DOCUMENT RESUME

ED 253 332 PS 014 888

AUTHOR	Hennart, Philippe; And Others
TITLE	The Ongoing Evaluation of Protein-Energy Malnutrition.
INSTITUTION	International Children's Centre, Paris (France).
PUB DATE	84
NOTE	101p.
AVAILABLE FROM	Children in the Tropics, Centre International de l'Enfance, Chateau de Longchamp, Bois de Boulogne, 75016, Paris, France ($4.00, or 20 French Francs).
PUB TYPE	Reports - Research/Technical (143) -- Guides - Non-Classroom Use (055)
JOURNAL CIT	Children in the Tropics; No. 149-150, 1984.
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Body Height; Body Weight; Children; Environmental Influences; *Evaluation Methods; *Family Health; Family Influence; Females; Foreign Countries; *Individual Needs; *Medical Evaluation; Medical Research; Neonates; *Nutrition; Pregnancy; *Public Health
IDENTIFIERS	Breastfeeding; Lactation; Protein Deficiency; *Tropics; Zaire

ABSTRACT

This report describes an approach for the evaluation of nutritional status implemented by the CEMUBAC medical mission to Zaire. Introductory remarks provide a brief, general discussion of the evaluation of individual, familial, and community nutritional status, as well as the evaluation of nutritional status and priorities. Section I focuses on the description of the nutritional status of various population groups. After a brief reminder concerning the difference between relative amd true malnutrition, the discussion outlines indicators of protein-energy nutritional status. Indicators are drawn from anthropometry, clinical observations, and biochemical findings. Several illustrations of each general category of indicator are provided and are discussed with regard to criteria such as age, sex, time, and place. Subsequent discussion focuses on considerations in determining the nutritional status of the most important special groups (women, lactating women, and newborn children). Again, illustrations of nutritional status evaluation are provided. Section II discusses decisive factors in collective protein-energy nutritional status. Supplemented by several examples, the discussion focuses on personal, familial, and environmental factors. Section III describes and illustrates the analytical approach, specifically: (1) analysis of the relative seriousness of the different forms of protein-energy malnutrition, and (2) analysis of different factors that may influence the nutritional status of population groups. Respectively, sections IV, V, and VI very briefly discuss the methodology of data collection, the methodology of data analysis, and the evaluation of health actions conducted by medical units. (RH)

ED253332

CHILDREN

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

THE ONGOING EVALUATION OF PROTEIN-ENERGY MALNUTRITION

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
International Children's Centre
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

PS 014888

in the TROPICS

2

1984 - N° 149-150

INTERNATIONAL CHILDREN'S CENTRE, PARIS

On Novembre 10, 1949, following negotiations between the Economic and Social Council of the United Nations and the French Government, this latter officially created, by decree, the International Children's Centre in Paris, making it available to the various specialized agencies of the United Nations as well as to all national organizations dealing with maternal and child health. Its purpose is to encourage, in the different countries of the world, the study of all problems concerning childhood, the training and education of personnel involved in work with children :

- health personnel : physicians, nurses, nuses'aides, auxiliaries, midwives, public health administrators ;
- social workers and judiciary personnel : social workers, judges of children's courts, psychologists, educators working with maladjusted children, « animators » of youth organizations and of rural areas ;
- pedagogic personnel : teachers, inspectors of preschool, primary, secondary and technical schools, schools administrators ;
- urbanists and architects ;
- economic and social planning personnel.

The objectives of the I.C.C. :

— to contribute to the training and education of personnel working with, and to others interested in problems related to child development in all countries, particularly in the Third World ;

— to stimulate and carry out researches involving all aspects of those disciplines which touch on childhood ;

— to work for the integration of childhood and youth programs into national plans for economic and social development ;

— to bring together those individuals and groups working in these areas and to provide them with documentation, guidance and advice.

1984 - N° 149/150

CHILDREN IN THE TROPICS

SIX ISSUES PER YEAR

edited by the
INTERNATIONAL CHILDREN'S CENTRE PARIS

Château de Longchamp
Bois de Boulogne
75016 Paris

PS 014888

CONTENTS*

THE ONGOING EVALUATION OF PROTEIN-ENERGY MALNUTRITION

INTRODUCTION 4

I. DESCRIPTION OF THE NUTRITIONAL STATUS OF POPULATION GROUPS 10

1. Protein-energy malnutrition : a reminder 10

2. Indicators of the protein-energy nutritional status 11
   2.1. Anthropometric data 11
   2.2. Clinical data 30
   2.3. Biochemical data 38

3. Some special groups 44
   3.1. Pregnant women 45
   3.2. Lactating women 49
   3.3. Newborns 55

II. DECISIVE FACTORS IN THE COLLECTIVE PROTEIN-ENERGY NUTRITIONAL STATUS 57

1. Personal factors 57
   1.1. Dietary intake 57
   1.2. Activity and energy expenditure 59

2. Familial factors 64
   2.1. Intrauterine growth and birth 64
   2.2. From birth to adulthood 65

3. Environmental factors 68
   3.1. Directly acting factors 68
   3.2. Indirectly acting factors 69

* Doctor Philippe Hennart, Free University of Brussels, Laboratory of epidemiology and social medicine ; member of the medical commission of the CEMUBAC (Scientific and medical centre of the Free University of Brussels for its cooperation activities) attached to the Institute for Scientific Research (IRS, Lwiro, Kivu - Zaire).

In collaboration with Doctor A.M. Masse-Raimbault (I.C.C.) and professor H.L. Vis (President of the medical section of CEMUBAC, Professor of Paediatrics at the Free University of Brussels).

III. THE ANALYTIC APPROACH - ANALYSIS OF THE FACTORS DETERMINING THE HEALTH AND NUTRITIONAL STATUS OF POPULATION GROUPS 73

1. Analysis of the relative seriousness of the different forms of protein -energy malnutrition 73

2. Analysis of the importance of the different factors which may influence the nutritional status of population groups 80
2.1. Breast-feeding 80
2.2. Family composition 83

IV. METHODOLOGY OF DATA COLLECTION 87

V. METHODOLOGY OF DATA ANALYSIS 90

VI. HEALTH ACTIONS AND EVALUATION 93

INTRODUCTION

The goal of regional health services everywhere is obviously the protection and improvement of the well-being of all those who live in that region. This well-being, or "human health", is closely dependent upon the environment in which people live. Although the World Health Organization defines health as "a state of complete physical, mental and social well-being", this definition is not only utopic, it is also too static and normative, and it may be preferable to use a more dynamic conception : "a state of harmonious balance between the individual, other people and the environment". In other words, health and illness are quite dependent upon the ability of individuals and groups to adjust to change.

In order to reach this goal, health professionals must practice total medicine ; that is, preventive and educational medicine as well as curative medicine, aimed at the individual but also at the family, implying that they take into account not only the health of each member of the family, but also the health, social and psychological interactions between the different family members at the various phases of family life. Last, the notion of community health reaches far beyond that of individual and family health, since it implies the actual participation of the community in the improvement of its health and has primary health care as its logical consequence.

However, this approach to family and community health, like all public health actions including primary health care, first requires the identification of the top priority needs within the community, followed by the definition of those individuals or groups of individuals who are least well adjusted as well as those times of life when adjustment is most difficult. Quite generally speaking, these high priority needs are first related to diet, environmental hygiene and reproduction in tropical regions. We must therefore obtain accurate data on the nutritional status of the population in these regions, identify the most frequent infections and parasitoses, and observe those problems linked with reproduction. The evaluation of needs and of top priority problems is actually a necessary preliminary to all public health actions, including primary health care, for the following reasons.

If the diagnosis is not correct, the planned health actions will not achieve the objective set, and may even increase risks for some or all of the people. If the basic evaluation is not done, it is impossible to evaluate the influence of health actions, and also of agronomic, economic and other actions on the health of the population.

Our objective in this study is not to attempt to impose a single, abstractly conceived methodological approach. It is to share information on the approach set up by the CEMUBAC in Kivu, Zaire, for the evaluation of nutritional status, thanks to which the top priority problems, and especially those linked with nutrition, may be permanently evaluated.

To identify the needs and risks of these communities, we must call upon a discipline known as epidemiology, which deals with human groups rather than with individuals as such. Thanks to descriptive epidemiology, we may describe the nutrional status of population groups, while analytic epidemiology analyses the risks to health.

Individual nutritional status : a constant adjustment

Individual nutritional status involves constant adjustment : it represents the ongoing addition of three basic factors, which are dietary intake, physiological requirements and energy expenditures.

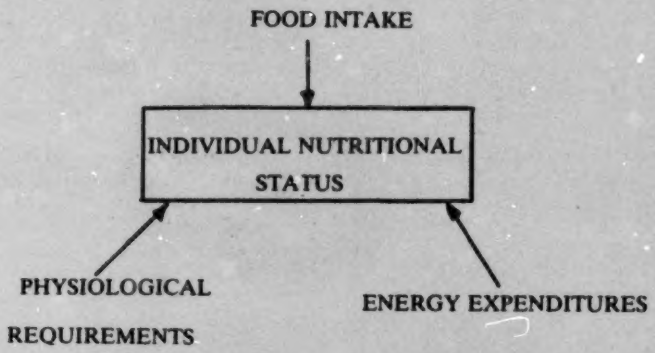

Figure 1 :
Basic elements constantly influencing individual nutritional status

Thus, nutritional status reflects the balance between these three factors. To a certain extent, everyone may attempt to maintain as satisfactory as possible a nutritional status by modifying one or another of these three components. Someone whose energy expenditure at work is particularly great will spontaneously increase his/her food intake, for example. Conversely, a person whose dietary intake is diminished may try to safeguard his/her nutritional balance by reducing the amount of energy spent at work and in everyday activities.

If we are to describe the nutritional situation of an individual or of a population in a given region, we should, ideally, not only define the nutritional status but also describe the food eaten, in terms of quantity and of quality, identify the energy expenditures and specify the physiological requirements of each person or group. We shall

restrain ourselves, in this study, to the evaluation of the nutritional status of the individual or of the population of a region. In itself, this approach is not necessarily sufficient for the comprehension of the real problems and the formulation of adequate solutions, but it is nonetheless indispensable for any evaluation of the individual or collective nutritional status, and it represents a necessary preliminary step in any evaluation of the nutritional situation in a region.

Evaluation of individual nutritional status

The nutritional status of each person is influenced by two types of factors : endogenous ones and exogenous ones. This influence is continuous, although some factors are more important than others at given times. Figure 2 shows some of these factors, but the list is not exhaustive, of course.

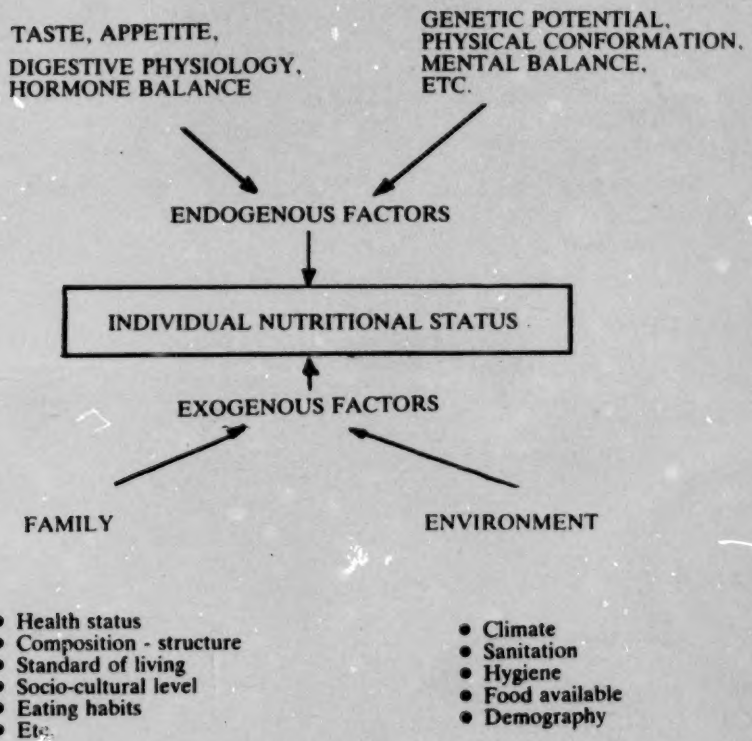

Figure 2 :
Elements constantly influencing individual nutritional status

Endogenous factors include, above all, the individual genetic potential, taste, appetite, the absorption and digestion of food, individual physiology, muscle development, hormone balance, mental balance, ... in other words, a series of highly complicated processes and phenomena, which are constantly at work in maintaining the individual nutritional status in a balanced state. Any pathology connected with one of these adjustment and regulatory processes may result in an imbalance in the nutrional status. It is important to identify these mechanisms ; they enable us to understand reactions to outside aggressions, but are obviously an integral part of each individual personality.

Exogenous factors are above all linked to the family, and then to the environment. For small children, family factors are preponderant, of course, whereas environmental factors are more important in older children and adults.

Generally speaking, the following are the main factors influencing the nutritional status of infants and small children :

— the child's nutritional status at birth, resulting from the action of numerous factors during foetal life ;
— nutritional intakes (their quality and quantity) ;
— infections (especially gastroenteritis, measles and lung diseases) ;
— parasitoses (especially ancylostomiasis and malaria).

In older children, heavy energy expenditures are added : they may be due to the hard work sometimes required of children, or to the long distances covered in order to reach school.

The main factors influencing the nutritional status of women are :

— their reserves and nutritional intake (qualitative and quantitative) ;
— energy expenditures for housework and farming ;
— complementary needs linked with pregnancy and lactation ;
— infections and parasitoses.

In addition, there are many interrelations between the different factors influencing the nutritional status of the infant and that of the mother (1). Assessment of the individual nutritional status should therefore always be a dynamic process, since the balance is constantly called into question by various factors, and depends on the past nutritional history of the individual, in particular (fig. 3).

Evaluation of the nutritional status of families

As we see in the analysis of the main factors influencing the nutritional status of mothers and children, the infant's nutritional status is closely linked with that of the mother, and vice versa. Indeed, a small birth weight may be the consequence of prematurity or of intrauterine malnutrition ; the duration of breast-feeding and the quantity and quality of the mother's milk may be influenced by her nutritional status ; last,

(1) Vis, H.L. Hennart, Ph. and Ruchababisha M. L'allaitement en zone rurale pauvre. L'alimentation et l'allaitement au Kivu (Zaire). Assignment Children, UNICEF, 1981, 55/56, pp. 171-189.

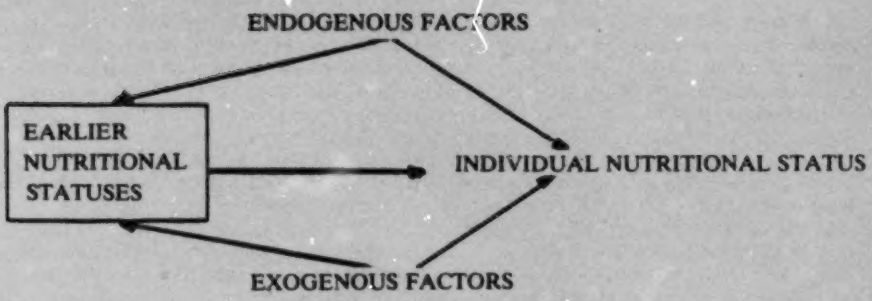

Figure 3 :
The evolution of the individual nutritional status involves constant adjustement to many factors

infections and parasitoses may occur at a very early date in breast-fed infants if the mother changes her behaviour toward the child and introduces complementary food too early. Similarly, the woman's nutritional needs are modified if she is pregnant or lactating. Her energy expenditures may be increased as well, if she carries her breast-fed child on her back, as custom requires. Last, the mother's nutritional status depends partly upon her past nutrition and therefore on her height and weight growth.

This makes it necessary to perform a nutritional diagnosis of the family as well as of the individual. This family conception of diagnosis does not simply mean that the nutritional status of each family member must be diagnosed, but it must take into account the nutritional and health interactions between the different individuals at various times of life. This family nutritional diagnosis is important, since health actions and individual or familial nutritional education may vary depending on the presence or absence of simultaneous malnutrition in the lactating mother and the breast-fed child, for example.

Evaluation of the community nutritional status

While some limited problems may be solved at the family level, such as the avoidance of overly early ending of breast-feeding by appropriate nutritional education and planned parenthood counselling, other problems are linked to the environment and influence the entire community. Insufficient food availability, rapid population growth, poor environmental sanitation or an excessively dry climate are examples of factors influencing the nutritional status of the entire population.

Evaluation of nutritional status and priorities

The evaluation of the nutritional status of each individual, including his/her food consumption, physiological requirements, energy expenditures and the identification of the family and environmental factors influencing it represents an interesting job, but a complicated and difficult one. If we also wish to observe this nutritional status constantly, and to follow its evolution, we further complicate the work.

If such a project is not limited to individuals, but aims at the population of a region, it becomes practically impossible. We are therefore obliged to take a different approach to this problem of the evaluation of the nutritional status of the individual and, beyond the individual, of the entire population of a region, and to think in terms of priorities.

Indeed, the health status of an individual, and his/her nutritional status in particular, is a state of balance. This balance may be broken by a great many factors, producing many risks for the individual, ranging from death to physical, mental or social disabilities. A child with severe protein-energy malnutrition is at greater risk of dying, for instance, than one in good nutritional health, through the risk of infection, in particular. If this malnutrition occurs during the first months of life, the risk of mental disability is also greater. A severely malnourished adult cannot do farm work or wage-earning activities as well as a healthy adult, and may therefore suffer a severe social handicap.

Thus, this approach goes much further than the simple description of the nutritional status of population groups, since it should lead to the definition of the priority needs of the population and the identification of those individuals and groups at greatest risk as well as the high-risk times of life. Two indispensable, complementary steps are required to attain this objective :

— the description of the nutritional status of the population, using a number of indicators (weight, height, arm circumference, presence of oedemas, etc.) and on the basis of some parameters related to the individual and to time and place : this is the field of descriptive epidemiology ;

— the analysis of the risks for the individual's future, with the demonstration and study of the possible relations between deaths and diseases caused by malnutrition and various factors playing a possible aetiological role : this is the field of analytic epidemiology.

For our description of the nutritional status of population groups, we dispose of many indicators of the protein-energy nutritional status of the individual. We shall first very briefly review the main features of the protein and energy components of malnutrition, so as to clarify the value of these indicators. Each of these indicators will then be discussed at greater length. Last, some examples will illustrate the variations in these indicators of nutritional status according to some criteria such as age, sex, time and place, all of which must necessarily be taken into account in the description of a nutritional situation.

In our second step, we will use examples to define those indicators of nutritional status which are associated with high risks of mortality, in order to bring top priority needs to light. We shall then very briefly provide a sample description of some factors which have been identified as risk factors for malnutrition.

Last, when we have made the value of these two complementary approaches clear, we will discuss the few steps which are indispensable to the achievement of the ongoing evaluation of the nutritional status of a population :

— data collection ;
— data analysis ;
— use of the findings.

I. DESCRIPTION OF THE NUTRITIONAL STATUS OF POPULATION GROUPS

1. Protein-energy malnutrition : a reminder

Malnutrition includes ailments caused by deficiency but also by excess. Ailments caused by excesses are increasingly frequently encountered in the industrialized countries, but they may also be seen in the developing countries, especially among the most privileged social classes. They represent a major public health problem, since they are very frequent and may well cause serious disorders, threatening the person's health.

Malnutrition caused by deficiency (1) is the result of a negative dietary balance. We divide it into two very different forms :

— relative malnutrition ;
— true malnutrition.

Relative malnutrition

The state of relative malnutrition is defined in comparison with the state of individuals whose nutritional intake is considered to have been better or optimal for more than one generation. This optimal intake has been defined by the FAO and WHO (in 1973) on the basis of the norms described in the United States for anthropometric and biological characteristics (2).

When a population has an insufficient nutritional intake for several decades, in comparison with these norms, its members develop adjustment processes characterized by :

— a slower rate of growth ;
— less expenditure of energy, that is, less productive work.

Thus, in the developing countries, the average birth weight is generally less than 3.300 kg, the weight chart shows a characteristic levelling off at 2 to 6 months, and the rate of weight and height growth is slow.

True malnutrition

True protein-energy malnutrition is a state characterized by anthropometric, clinical or biological symtoms and one which constitutes a risk for the health of the individual:

---

(1) Issue 138/139/140 of "Children in the Tropics".
(2) Issue 147/148 of "Children in the Tropics".

For simplicity's sake, these states of malnutrition are usually divided into :

— general undernourishment, leading to marasmus ;
— pure protein malnutrition, or kwashiorkor.

However, pure forms of malnutrition are rarely encountered in the developing countries. There is almost always a mixture, although one or the other state may predominate. The general term of protein-energy malnutrition or protein-calorie malnutrition (P.E.M. or P.C.M.) is therefore used.

Theoretically, each type of dietary deficiency has its specific features. Tables 1, 2 and 3 present some anthropometric, clinical and biological data for pure protein deficiency and general deficiency. The indicators ordinarily used to measure variations in individual nutritional status are also inscribed.

We may see that anthropometric data may mostly be used to assess the state of general undernourishment, since height and weight growth are not usually disturbed in pure protein malnutrition, which sets in very rapidly, nor is the subcutaneous adipose tissue, which is retained. It is preferable to compare the different anthropometric data with local curves, so as to take relative malnutrition into account.

We may also note that the clinical and biological data mostly express the state of protein malnutrition. For one thing, the hair and skin are not altered in marasmus, while they are considerably deteriorated in pure kwashiorkor. Changes include discolouring of the hair, cheilitis and pellagroid dermatosis, which is not limited to the surfaces exposed to sunlight, as in the case of true pellagra. This dermatosis is characterized by hyperkeratosis, non-inflammatory ulcerations, depigmented areas and peeling skin, to a varying extent. In addition, the plasmal proteins and albumin produced in the liver are less abundant in kwashiorkor and normal in marasmus. Other proteins produced by the liver are also diminished in kwashiorkor ; they include the transferrins, prealbumin and the retinol-binding proteins. However, these proteins have a shorter half-life and mostly indicate a lack of protein in the diet during the previous days and hours.

2. The indicators of protein-energy nutritional status

2.1. Anthropometric data

2.1.1. Weight

Weight is the most usual anthropometric indicator, and health workers as well as parents are generally well aware of its value. Loss of weight is a major clinical sign of the energy component of protein-energy malnutrition. On the other hand, weight is not a valuable indicator in pure protein malnutrition, since it may not decrease and may even increase if the child has oedemas.

These findings call for two important remarks :

— if weight measurement is to be used as an indicator, it should be repeated at regular intervals, if possible. These repeated weighings may be performed within the hospital health structures, in the Mother and Child Care Centres (MCC), in schools, or in the framework of longitudinal surveys. However, weighing is most often done

Table 1

	PROTEIN MALNUTRITION	MARASMUS	BIOLOGICAL INDICATORS
ANAEMIA	++	+	
SERUM ALBUMIN	LOWERED	NORMAL	CONCENTRATION
TRANSFERRIN	LOWERED	NORMAL	CONCENTRATION
PREALBUMIN	LOWERED	NORMAL	CONCENTRATION
RETINOL - BINDING PROTEINS	LOWERED	NORMAL	CONCENTRATION

Table 2

	PROTEIN MALNUTRITION	MARASMUS	CLINICAL INDICATORS
DISORDERED HAIR	+++	±	YES/NO
DISORDERED SKIN	+++	±	YES/NO
OEDEMA	+++	±	YES/NO
HEPATOMEGALY	++	±	
PSYCHOLOGICAL BEHAVIOUR	ANOREXIA APATHY	APPETITE NERVOUSNESS	

Table 3

	PROTEIN MALNU-TRITION	MARASMUS	ANTHROPO-METRIC INDICATORS
STUNTING	±	++	HEIGHT FOR AGE
WEIGHT LOSS	– OR +	+++	WEIGHT FOR — AGE — HEIGHT
REDUCED SUBCUTANEOUS FATTY LAYER	±	+++	ARM CIRCUMFERENCE — FOR AGE — FOR HEIGHT THIGH CIRCUMFERENCE SKIN FOLDS

under isolated conditions, during cross-sectional surveys. Methods of comparison with other findings, mostly through local curves, make use of these data possible, but serial measurements do provide a better indication of actual growth ;

— assessment of the significance of weight requires that height, the proportion of fat, muscle and bone, and the possible presence of a pathological overload (such as oedema) or of a major water loss (dehydration) be taken into account. Weighing should therefore be combined with other measurements and with clinical examination. The same is true for the other indicators of protein-energy nutritional status : no single indicator may be used to evaluate the nutritional status of an individual or a group, since that would certainly lead to an erroneous analysis of the findings.

Young children, and in any case all children under two years old must be weighed naked. The weight is calculated in kilogrammes, and in tenths of kilogrammes at the least. When the child is too restless to stay still on the scale, the mother may be weighed alone, then with her child in her arms (double weighing). The child is thus calmed by the mother, and the reading is more accurate. Older children will remove their shoes and most clothing, retaining only their drawers or shorts. Care should be taken in using the scales :

— secure the movable parts before moving it about ;
— place the scale on a stable, horizontal surface
— check the scale regularly, once a day before beginning weighings, at the least, and preferably twice a day. This should be done using specially calibrated weights.

Only if such care is taken can many measurements be put together and analysed so as to describe the nutritional status of a population group. Indeed, this approach is only possible if the measurement method is standardized and strictly respected by all health workers.

Although weighing is generally performed in all health structures and even outside of them, during cross-sectional studies, the analysis of the data at the community level is rarely done. The data should be processed locally, with the participation of all those health workers who participate in collecting them. This should be done at regular intervals, depending above all on the number of weighings performed. Data processing may be done simply, manually, or with the help of a small adding machine, and therefore entails no major expense, and requires no special preparation of the data before analysis.

The data may be expressed in different ways, and more specifically, in three complementary ways :

— as the average, and the standard deviation from the average, the number of weighings ;
— as groups, generally as percentiles, that is as groups each representing 1 % of all measurements. Thus, the 10th percentile is the weight below which 9 % of the children's weights are located, and above which 89 % of weights are located. The 50th percentile represents the median weight ;
— as the number of figures, expressed in percentage, above and below a given threshold.

Example (1)

In a rural hospital in southern Kivu (Zaire), each child is weighed at birth. At the end of the year, the birth weights are collected and analysed with respect to many factors. The weights may be expressed in various ways in these different analyses. The overall results were as follows for 1982 :

Birth weight (Kabare hospital)

- Number of children born : 1,075
- Average weight and standard deviation : 2.97 ± 0.45
- Percentiles : 10 : 2 kg
  50 : 2.99 kg
  90 : 3.57 kg
- Children weighing 2.5 kg or less : 14.2 %

This third way of presenting the data calls upon the concept of the threshold, below which the risk of death for the newborn is higher. Although many studies throughout the world show that the risk of death is greater for children weighing less than 2.5 kg at birth than for the others, there is no proof that this is the case everywhere or that this threshold should be set at 2.5 kg at all times and in all places. In reality, an analytic epidemiological approach is required to determine what risks are run by children when the birth weight drops, below what figures this risk is increased, and the critical figures to be considered in local actions and their evaluation.

This last way of expressing the results may be easier to achieve in field work, and it also avoids a major trap. Indeed, if the data are expressed as an average for the population, some problems may be overlooked. Changes in the distribution of the population around the average are not expressed by a change in the average, whereas such changes may have major effects on the health of the population.

Example (1)

The average weight of children born at the rural hospital in Kabare remained practically the same over a period of several years.

However, the percentage of children weighing under 2.5 kg was no longer the same.

In other words, despite an identical average weight at an interval of several years, more newborns now have a birth weight of 2.5 kg or less. Analytic epidemiology clearly indicates that children weighing less than 2.5 kg at birth run a greater risk of death than the others. In public health terms, the results observed at the end of several years are not at all identical.

If the same children may be weighed at very regular intervals, for instance every month at the infant consultation or every week in the hospital, we may then calculate the variations in weight (gain or less) for the group of children involved.

---

(1) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

Weight at birth (kg)

Year	Number (n)	Average ($\bar{M}$)	± Standard deviation (± SD)
1976	716	2.97	± 0.42
1982	1,075	2.97	± 0.45

Weight 2.5 kg or under

Year	Percentage
1976	11.7
1982	14.2

Any description of the nutritional status of a population group must take four important factors into account : age, sex, place and time ; this is particularly true when weight is taken as the indicator.

Age : a child's weight is only an indication if his/her age is taken into account. Similarly, the rate of growth varies with age and weight gain in one month may vary from one age to another. This means that when the weight of the persons examined is expressed in terms of percentiles (or averages, etc.), their age is always taken into account. This enables us to chart the weight curve of all the children in a region : this curve shows the figures for the different percentiles according to age.

Example (1)

After four to six months of routine work by medical workers at infant consultations in Idjwi (southern Kivu, Zaire), a local curve was established. Figure 4 shows the evolution of the percentiles 95, 50 and 5 (from top to bottom) of boys weight with respect to their age.

When we have few figures for each age or age group, only the 50th percentile may be calculated, but the result is already quite interesting, although incomplete.

If the child's age is not known precisely, we may compare his/her weight with his/her height and establish a weight-for-height curve. For each height, the different weights collected will be distributed, and the different percentiles noted. This curve depends both on individual factors and on the environment, since weight and height are influenced by both factors.

---

(1) Unpublished data, Bosswyt, M. et al. CEMUBAC, 1968 to 1972.

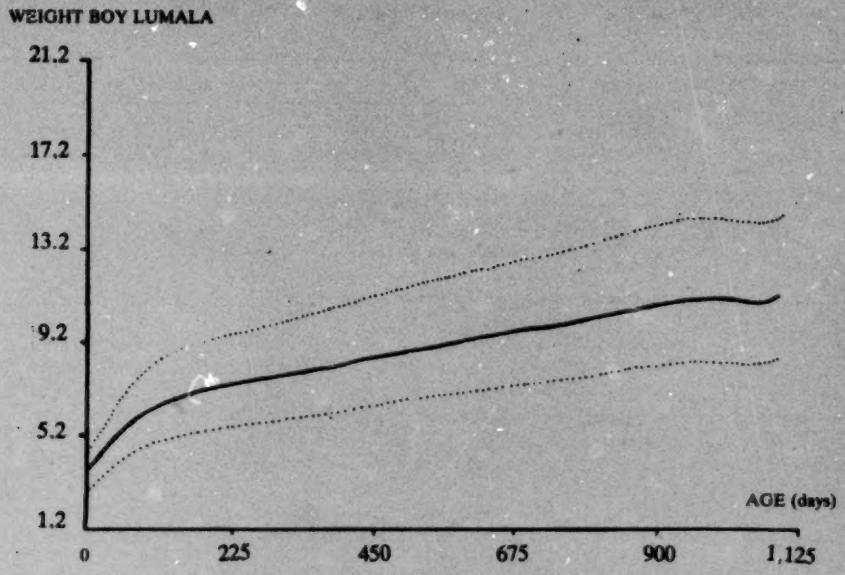

Figure 4 :
Evolution of boys weight with age
Data collected during infant consultations in Idjwi (1968-1972)

Sex : boys and girls do not have the same weight and rate of weight growth. At birth, boys already weigh about 200 to 300 g more than girls, on the average. Boys maintain this slight superiority throughout their growth, until the onset of puberty. The rapid pubertal growth spurt occurs earlier in girls, who are consequently taller, heavier and more mature than boys of the same age, on the average, during several years. Since the pubertal growth spurt lasts longer and is more intense in boys than in girls, adult men are taller, heavier and stronger than women, on the average. Data for boys should therefore be processed separately from that of girls, and two distinct weight curves should be established, either according to age or to height.

Place : a child's weight, at a given age, is influenced by many factors which we shall discuss at greater length. The most important of these are certainly the child's weight at birth, the food eaten (its quality and quantity), energy expenditures and last, infections and parasitoses. The child's weight and weight growth are therefore influenced by his/her environment. Children's weight growth must therefore be studied with respect to their environment : this requires the establishment of a local growth curve based on weighings performed on a specific population group.

Within a given region, birth weights and weight growth may differ in rural and urban areas, at low or high altitude, etc. Differences in food availability, money income, environmental hygiene, parents level of education and access to health care partially explain the differences observed.

Example (1)

In Kivu (Zaire), birth weight is higher, on the average, in urban areas than in the different rural environments in the region (table 4).

This finding is of somewhat limited value, since all of these children are born within a health structure, whereas we know that a non-negligeable proportion of mothers still give birth at home. A recent study (2) shows that nearly 25 % of mothers in urban areas still give birth at home, and this proportion is even higher in rural areas (over 60 %).

This study also shows that in both environments, younger women and the most educated ones tend to give birth in health structures more often than the others. Figures collected exclusively in the health structures should therefore be regarded with distrust, since women with a higher socio-economic status attend health structures more often than the others, on the average, both in the developing countries and in the industrialized countries.

Table 4 :
Children's birth weight in different environments.
All measurements are made within health structures.
*** P = 0.001 or under

	Number (n)	Average (M)	± Standard deviation (± SD)
Urban area			
• Bukavu	780	3.01	± 0.45
Rural area			
• Kabare	1,075	2.97	± 0.45
• Kirotshe	635	2.90	± 0.46
• Rutshuru	521	2.88	± 0.49
• Masisi	425	2.89	± 0.49
F Test		10.96***	

(1) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

(2) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

If such differences exist within a same region, it is not surprising to find still greater variations in weight growth between children living in different regions of a same country, not to mention those living in different countries. This is obvious if we compare the growth curves of children living in developing countries with those of children living in industrialized countries.

Example (1)

Figure 5 shows the 50th percentile of the weight curve of Shi and Havu boys in comparison with the 50th percentile of the weight curve of boys in Saint-Gilles, Belgium (2). The weight curve of boys in Kivu, Zaire levels off towards the age of 4 months ; this is characteristic of the developing countries.

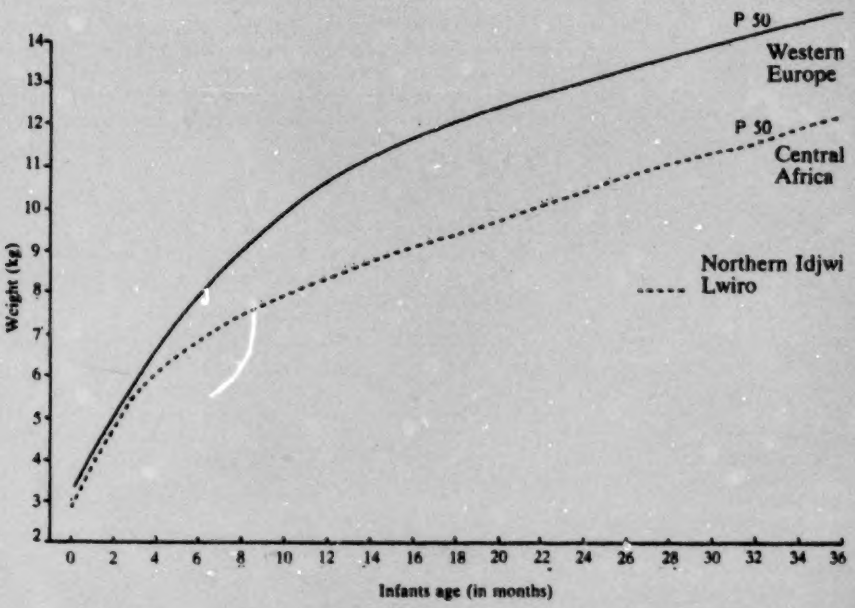

Figure 5 :
Comparison of median weights for Shi and Havu boys (Kivu, Zaire) and boys in Saint Gilles (Belgium)

(1) Vis, H.L. Hennart, Ph. L'allaitement maternel en Afrique Centrale. Assignment children (UNICEF), 25, 87-107. 1973.

(2) Wachlhoder A. and Graffar, M. Courbes de croissance en percentile des mesures biométriques (poids, taille, périmètre céphalique) des enfants belges de 0 à 15 ans, garçons et filles. Centre d'Etudes de la croissance, Bruxelles. 1973.

Time : during a given year, children of the same age may have an average weight and an average weight gain which differ according to the time of year at which they were weighed. Indeed, in rural areas where people are practically self-sufficient, food intake and energy expenditures, in particular, may vary enormously from one season to another. This means that weight variations are mostly seen in regions where the family's food consumption, expressed in terms of energy intake, varies with the seasons, as is the case in the Sahel, for instance, or in Nepal. In urban areas, where a money income exists, monthly variations in food intake may be observed, and the nutritional status of children may vary concomitantly.

While such variations in weight may be seen in the course of one year, they may also be seen from year to year. Indeed, when the environmental hygiene, the overall socio-economic level of the population or its nutritional situation varies with the years, the rate of weight growth and therefore the weight curve may vary with time for the same population.

Example (1)

Table 5 compares the weight for height of children in the rural area of Kabare (Kivu, Zaire) with the local norms, established 20 years ago (2). The measurements were made outside of any health structure, during surveys performed in the framework of the ongoing evaluation of the nutritional situation in the region. We may see that the frequency of children whose weight for height is below the 5th percentile of the local curve is far greater than it was 20 years ago, since it is now 32 % of children aged 0 to 5 years and 24.5 % of those aged 6 to 14 years. Thus, the entire growth curve is now shifted downward, indicating slower growth in these children.

Table 5
Comparison of weight for height in Kabare children with the norms established for the same region 20 years earlier

Frequency of weight-for-height (%)	Rural area of Kabare	
	0 - 5 years (418)	6 - 14 years (298)
above 95th percentile	1.0	1.3
percentile 95 to 50	13.2	10.4
percentile 49 to 5	53.8	63.8
below 5th percentile	32.0	24.5

(1) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

(2) De Maeyer, E.M. Courbes locales (population Shi). Unpublished data. 1959.

Once the children's weights have been collected and expressed in this way at the community level, the data must be analysed and used. The different approaches discussed here are also valid for other data, be they anthropometric, clinical or biochemical.

A simple description of the rate of growth of children in a region is interesting in itself, since it indicates those times of life when growth is more rapid. These age periods are of course more critical periods for the child's health and nutritional status, since any outside aggression has greater repercussions on growth if it occurs during these periods.

The comparison of the local curve with one established in another region is also highly instructive. In the example described above, where the median weights of Shi and Havu boys are compared with the median weights of boys in Brussels, the simple superimposing of the curves shows that the differences in weight observed in children aged 6 to 12 months are mainly attributable to the levelling off of the growth rate observed toward 4 months. If we suppose it to be desirable for children in Zaire to have exactly the same growth rate as Belgian children, we would have to act when they are 4 months old, and probably well before that age. Such a desire is of course illusory, since the children live in completely different environments, and in fact there is no proof that the growth of Belgian children represents a model to be imitated. In itself, this comparison does not tell us why the rate of growth is modified at this time of the child's life. However, the indentification of the time when this levelling off occurs may be important in the establishment of our health actions.

The comparison of a local curve with another, previously established local curve is also quite instructive. Such a comparison enables us to evaluate the influence of all spontaneous and/or intentional changes in environmental factors on the children's growth and, in the long run, to predict the subsequent course of events, all things being equal. Any tendency of the weight curve to accelerate or slow down should of course be interpreted according to the local context, but the observation of this phenomenon is obviously important to the entire community.

Last, and above all, this description of the weight growth of children will inspire thought, observations and surveys so as to identify factors of risk for the health and nutritional status of community members. These will also identify persons at greatest risk within the community. Such an approach, based on local epidemiology and on the notion of risk, should enable us to define needs and top priority actions at the community level.

2.1.2. Height

Height is a commonly performed linear measurement ; the method used depends on the child's age. Children under two years old are measured in a prone position. Indeed, height measurement standing up is quite inaccurate in small children, since they are uncooperative. Babies are laid on a board placed on a flat surface. The head is placed against a small board, the knees extended - this generally requires the help of an aide - and the feet maintained at a right angle with the legs. The sliding ruler is then brought to rest against the heels, and a reading shows the length from the top of the head to the heels. If the child is over two years old, he or she may easily stand up, and a measuring stick or a ruler fastened to the wall is used. The child is measured

without shoes, feet parallel, with his/her heels, buttocks, shoulders and heat in contact with the wall. The head must be help up so that the lower edge of the eyeballs is on the same horizontal plane as the external auditory canal. The sliding ruler is then slowly lowered until it meets the top of the head. The graduated ruler enables accurate measurement to 0.5 cm.

Growth retardation occurs under a number of circumstances, and particularly during dietary deficiencies. Since many factors may influence growth, the evolution of a child's height should be considered in reference to local curves. If the diet is mostly lacking in calories and if the deficiency persists, height retardation may be great. On the other hand, protein malnutrition is usually an acute ailment which does not leave time for height to be affected. A major lag in height may also be seen in other dietary deficiencies such as zinc deficiency.

Like weighing, height measurement is usually done routinely in all health structures and it may also be done easily outside of these structures during field investigations. The data thus collected must then be analysed at a community level and data processing should be done locally.

There are two different, complementary ways of expressing the findings :

— as an average, with standard deviation from the average, for the number of measurements made ;
— as groups, usually percentiles. The 50th percentile thus corresponds to the median figure.

Example (1)

Every year, nurses routinely measure the height at birth of infants in the maternity wards of southern Kivu, Zaire ; these figures are collected and expressed in different ways.

In 1982, the overall results were as follows :

Height at birth (maternity wards in southern Kivu)

Number of measurements : 2,638
Average height and standard deviation : 47.7 cm ± 2.4
Percentiles 10 : 43 cm
50 : 48 cm
90 : 50 cm

As in weight growth, we may learn much about the rate of height growth by collecting measurements of the same children at very regular intervals.

These measurements may be used to describe the community, provided the same four factors are taken into account : age, sex, place and time.

---

(1) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

Age : the child's height varies with age, of course, so that height is always expressed in terms of the child's age. We then set up a curve for the height development of children in a given region or simply for children attending one or several infant consultations in the region. Indeed, such a curve may be based on data collected at infant consultations within a region or during cross-sectional surveys organized outside of any health structure.

Practically speaking, the data is grouped according to age group for the calculation of the different percentiles, the median and the average. We may group children aged 1 month ± one week, for example, and do the necessary calculations, then do the same operations for children aged 2, 3, 4 months, etc. One of the most frequently encountered obstacles in the establishment of a height or weight curve, using data collected within a community, is that of the sample : should we use all data or not, should we eliminate some of them for various reasons ? We may eliminate the data on ailing children, for instance, or on those with clinical signs of malnutrition. The answer to this question depends on one's objective. If the objective is to describe the nutritional status of the population, such as it may be observed during a given period, or if it is to assess the activities undertaken within a community and to reflect on the findings, it is preferable that no data be excluded. Indeed, any exclusion would create a bias linked with the criteria used and would result in an idealized curve unrelated to the actual situation.

Let us take an example : the exclusion of the heights or weights of children with parasites would be one logical approach if we wish to obtain a reference curve for the growth of children in the region, but such a curve would probably be far from corresponding to reality, especially in the tropics, where parasitoses are so frequent. Under these conditions, the best solution is to exclude no one, and to specify as clearly as possible the method used : number of measurements, lapse of time, lack of exclusions, groupings used, etc.

Other characteristics of nutritional status will be obtained simultaneously for the same children : frequence of oedemas, for instance, as well as factors influencing nutritional status, such as the frequency of intestinal parasitoses, for example. This is a more realistic method, and avoids any selectivity based on criteria which are too often arbitrary.

Sex :the rate of height growth varies with sex. Data for boys and girls should therefore be processed separately, and two different height curves established.

Place : for a given age, a child's height is also influenced by many factors (genetic factors, others linked with the environment). This environment varies from one region to another, from one part of the region to another. For instance, factors such as food availability and environmental sanitation, which affect the nutritional status of a community's children vary considerably between rural and urban areas. Variations also exist within a given environment, be it rural or urban.

Example (1)

In Kivu (Zaire), children under two years old who are breast-fed show far less satisfactory height growth in rural areas (near Kabare) than in urban areas (Bukavu).

---

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

Figure 6 shows the evolution of median heights (50th percentiles) for boys in urban areas (U) and in rural areas (R). The curves were based on 500 measurements in each of the two areas and none of the children examined was hospitalized. The measurements were first grouped by one month, then by two months.

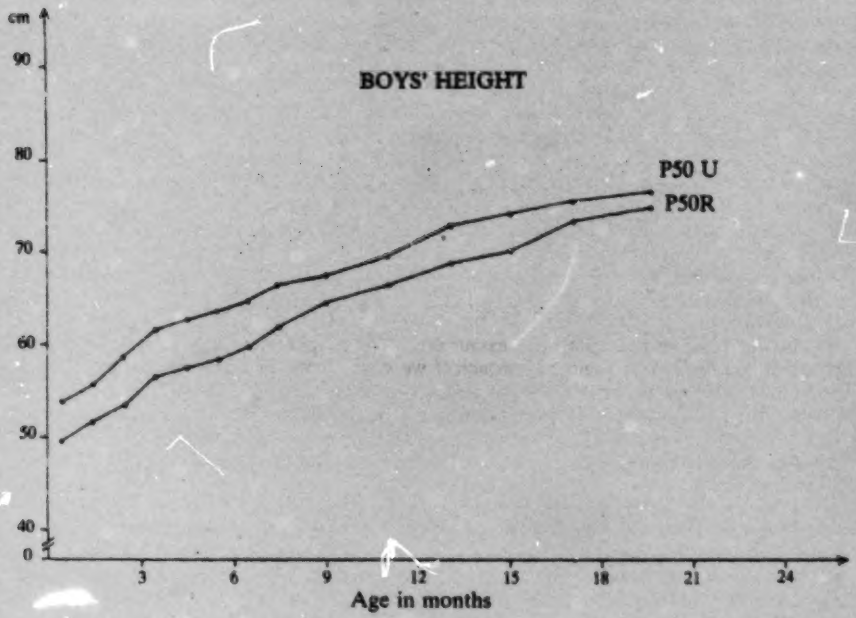

Figure 6 :
Median heights of urban (U) and rural (R) breast-fed boys accordings to age

Time : different environmental factors which influence children's growth may also vary with time, within a given region. These changes may cause growth to accelerate or to slow down. Gradual acceleration may occur when the population's socio-economic situation improves, for example. Conversely, children's growth may slow down if the nutritional situation in the region deteriorates. Since small height for age is an indicator of chronic malnutrition, variations in height growth within a same region over time and for a same population indicate persistent changes in one or several environmental factors. Lack of variation in children's growth does not necessarily mean that the environment has not changed, but that the results of the different factors influencing health and child growth cancel out. In addition, a change in the rate of growth may simply indicate a major population migration.

Example (1)

If we return to the data presented above - that is, the heights of breast-fed children in urban and rural areas, and if we compare them with data collected nearly 20 years ago in the same region (De Maeyer, 1959), we find that urban children may grow a bit faster but rural children have slower growth (table 6). This comparison takes both the age and the sex of the children into account. This finding is of course quite important for the population of the region, since it suggests that urban life now stimulates more rapid growth than 20 years ago, whereas living conditions, and the nutritional situation in particular, have gradually deteriorated in the rural area of Kabare during that period.

Table 6
Comparison of height-for-age of breast-fed children in urban and rural areas with local growth curves (De Maeyer, 1959)

Height-for-age	Urban area (n = 501)	Rural area (n = 580)
95th percentile or above	21.6	7.8
Percentile 94 to 50	58.6	28.6
Percentile 49 to 5	17.8	39.3
Under 5th percentile	2.0	24.3

2.1.3. Arm circumference

The arm circumference is a measurement frequently used in the evaluation of the nutritional status of a population group. It depends not only on the size of the humerus that on the amount of soft tissue such as muscles and fat, and this is what interests us. When this soft tissue is poorly developed or depleted, we have a major sign of protein-energy malnutrition. It should be noted, however, that arm circumference indicates the extent of both muscles and subcutaneous fatty tissue. In major energy deficiency, the arm circumference may be very low due to the depletion of the subcutaneous fatty tissue and of the muscle. If the protein component is more important, the wasking of the muscle may be hidden by the relative conservation of the subcutaneous fatty tissue. Like all other anthropometric data, arm circumference has its limits, and the analysis of its figures and their variations must be integrated in the analysis of other clinical, anthropometric and biochemical data, particularly in the tropica, where protein deficiency is considerable.

It is more practical to measure the arm at its half-way point, since that area is easy to reach, even in infants. Arm circumference is measured down to 0.1 cm using a flexible measuring tape gently but firmly held around the limb. Care must be taken to avoid pressing too hard on the soft tissues. It is performed on the median point of the left arm, in general, half-way between the acromion and the olecranon. If no measuring tape is available, a special strip of non-elastic cloth may be prepared.

---

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

Like the other anthropometric data, these may be expressed as averages (and standard deviation from the average), medians (and the diferent percentiles) and percentages (data above or below a given threshold). Here too, the description of the results must take the four major factors into account : age, sex, place and time.

Age : Arm circumference varies with age in a very peculiar way. Indeed, until the age of 12 months it increases gradually. Between 12 and 60 months it hardly changes, increasing by only 1 or 2 cm. In other words, arm circumference remains practically the same from 1 year to 5 years. This lack of variation at a time of life when protein-energy malnutrition is frequent is quite valuable, of course, and facilitates the interpretation of the results. However, the relative stability of arm circumference is due to variations in the respective amounts of muscle and subcutaneous fatty tissue. At the age of one year, children have relatively more subcutaneous fat on their arm whereas at 5 years they have more muscle and less fat. After age 5, arm circumference increases gradually, but its measurement alone does not indicate the respective amounts of fatty tissue and of muscle. If the children's age is not known precisely, arm circumference may be correlated with height, and a curve established for arm circumference/height.

Sex : as for the other anthropometric data, it is preferable to analyse them with reference to the child's sex. While girls usually have a smaller arm circumference than boys, the difference is minor (a few millimetres) and in adults the differences are hardly any greater (1).

Place : major differences may be seen in a given region if environmental factors differ. A less satisfactory nutritional situation in one region, for instance, may result in a poorer development of children's muscle and fatty tissues.

Example (2)

In Kivu (Zaire), for instance, breast-fed children under two years old have a lower average arm circumference in a rural area (near Kabare) than in an urban area (Bukavu). These data (table 7) were measured in the same children as in the two previous examples ; that is, in non-hospitalized children. The measurements have been grouped by three-month periods in this table. These results confirm the existence of a major difference in nutritional status between rural and urban children. If the children's sex is taken into account, the analysis shows the same results.

In the last example, the child's sex is not taken into account in the presentation of the data. Indeed, in each of these areas the average arm circumference was the same in boys and girls, and the proportions of boys and girls is the same in the two samples.

Time : when a child is suffering from protein-energy malnutrition, the arm circumference decreases since the soft tissues are depleted. If the population of one region suffers a dietary deficiency due to a natural catastrophe, for instance, the arm circumferences/age will be lower than before, on the average. Conversely, the intro-

---

(1) Jelliffe, D.B. The assessment of the nutritional status of the community. World Health Organization, Geneva. Monograph series, n° 53. 271 p. 1966.

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

Table 7
Arm circumference of breast-fed children according to age and comparison between urban and rural data.
Average ± standard deviation

Age (months)	Arm circumference (cm)	
	Urban area	Rural area
0 - 2	12.6 ± 1.5 (313)*	10.9 ± 1.9 (121)
3 - 5	13.8 ± 1.5 (164)	11.6 ± 1.4 (141)
6 - 8	13.9 ± 1.4 (87)	12.1 ± 1.9 (84)
9 - 11	14.0 ± 1.3 (65)	12.6 ± 1.5 (91)
12 - 14	14.0 ± 1.1 (53)	13.2 ± 1.4 (90)
15 - 17	14.3 ± 1.3 (33)	13.1 ± 1.0 (61)
18 - 23	14.6 ± 1.3 (20)	13.5 ± 1.2 (70)
24 and over	———	13.8 ± 1.1 (45)

* Number of measurements.

duction of new agricultural techniques, for example, or the establishment of a new communications network for a region or a village may improve the general nutritional status, as indicated by an increased arm circumference.

2.1.4. Thigh circumference

This is much more rarely measured. Like the arm circumference, this measurement depends both on the muscles and on the subcutaneous fatty tissue. First, we must identify the midpoint between the knee and the iliac crest : the thigh circumference is then measured, taking care that the tape be held neither too tight nor too loose. This indicator is rarely used but its value is nonetheless considerable. In adults, for instance, the thigh circumference is approximately twice that of the arm circumference. For this reason, any moderate variation in an individual's nutritional status, causing a modification in the muscles and/or fat will be more reliably identified by the measurement of the thigh circumference than by that of the arm circumference.

Example (1)

As a rule, in the developing countries, a higher standard of living contributes to greater food consumption and decreased energy expenditure. This change in socio-professional status may affect an individual's nutritional status by increasing his/her subcutaneous fatty tissue, sometimes excessively.

In Kivu (Zaire), we have measured the arm and thigh circumference of 700 lactating women in an urban area and compared the anthropometric data for these women with their socio-economic level. A series of criteria were used to define this level.

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

including attendance or non-attendance of an elementary school. Table 8 shows that their arm circumference hardly varied, on the average, whereas there were greater variations in thigh circumference. For this criterion, as for others, thigh circumference was seen to be a more sensitive indicator of variations in mother's nutritional status.

Table 8
Comparison of arm and thigh circumference of lactating women in an urban area, for a given criterion.

Circumference	Urban area	
	Elementary school attented	Not attented
Arm circumference (in cm)	25.7 ± 2.3 (156)	26.1 ± 2.5 N.S. (577)
Thigh circumference (in cm)	46.6 ± 4.4 (156)	49.0 ± 5.1 *** (577)

N.B. : the test results (covariance analysis) are adjusted for the age of the breast-fed child. Significance levels : N.S. = Not Significant ; *** P = 0001 or under.

2.1.5. Head circumference

Paediatricians are quite familiar with measurement of the head circumference, since the size of the head may increase in some pathological states such as hydrocephalus or decrease, as in microcephalus. The head circumference depends essentially upon the size of the brain, and depends to a very slight extent upon the thickness of the scalp tissues and of the skull. When the brain tissue grows, mostly toward the end of foetal life and during the first years of life, especially the first year, the head circumference increases rapidly. In the USA, for instance, the median head circumference for girls is 34.8 cm at birth, 45.8 cm at 12 months, 48 cm at 24 months and 49.2 cm at 36 months (1). After that, the head circumference only increases very slightly.

While the size of the brain may theoretically vary, like the thickness of the soft tissues and of the skullbones, with nutritional status, no research has thus far proved the specific value of this indicator in the evaluation of infantile protein-energy malnutrition. Practically, however, head circumference may be used for the evaluation of the small child's age.

The head circumference is measured using a flexible, non-extensible measuring tape. The child's head is maintained in a stable position and the greatest circumference is measured, crossing the frontal bone, just above the orbital crests and on the occipital bone at the most protruding point. It is measured to 0.1 cm. The results are

(1) Hamill, P.V.V., Drizd, T.A., Johnson, C.L., Reed, R.B., Roche, A.L., Moore, W.M. Physical growth : National Center for Health Statistics percentiles. Am. J. clin. Nutr., 32 : 607-629, 1979.

expressed in exactly the same way as for the other anthropometric data and the description of these results takes the same factors into account (age, sex, place and time).

Example (1)

In Kivu (Zaire), the nutritional status of breast-fed children was defined by a series of anthropometric measurements, including head circumference. Table 9 compares the median figures for the head circumference of urban and rural girls. The measurements are grouped by periods of two months. The median figure for head circumference was found to be systematically lower in the rural area than in the urban area, but the difference was very slight for each group. This difference was all the more minor since the nutritional situation is actually quite different in these two environments, as we have already seen, and the head circumference alone does not identify this situation.

Table 9
Comparison of the median figures for head circumference of breast-fed girls in urban and rural areas

Age (in months)	Head circumference	
	Urban area	Rural area
0 - 1	37.9 (91)*	37.2 (37)
2 - 3	39.9 (100)	39.4 (57)
4 - 5	42.0 (41)	41.2 (33)
6 - 7	43.6 (29)	42.6 (31)
8 - 9	44.5 (23)	43.6 (38)
10 - 11	45.0 (17)	44.7 (26)
12 - 13	45.9 (12)	45.5 (27)
14 - 15	46.0 (23)	45.3 (33)
16 - 17	46.5 (7)	46.0 (13)

* Number of measurements

2.1.6. Skin folds

The thickness of the skin fold depends on the thickness of the skin and of the subcutaneous fat. Skin folds tell us how much subcutaneous fat is present and how it is distributed ; in other words, the state of the person's energy reserves.

Calipers are used to measure the skin folds (Harpenden's calipers, for example). The skin is seized and the longitudinal skin fold lifted between the thumb and another finger. The calipers are then placed slightly below the fingers at a depth equal to the height of the skin fold and three measurements are made when possible. The average of these three figures is then calculated and the result noted. As for the arm circumfe-

(1) [illegible]rt, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 198[illegible]

rence, the left side of the body is chosen. The zero point of the calipers must be carefully adjusted each morning and if possible in the course of the day.

The skin fold may be measured on different parts of the body : the choice depends on some criteria such as the objective of the study or the easiness of the operation. In practice, the triceps skin fold is generally chosen, halfway between the acromion and the olecranon. The skin fold is parallel to the length of the arm, which hangs at rest at the side. The subscapular skin fold may also be measured. This is done just under and along side of the angle of the left shoulder-blade, at an angle of about 45° to the spinal column. Some authors also measure the supra-iliac skin fold.

The technique used is not an easy one, and the quality of the measurements performed must be routinely supervised. Indeed, if the results are to be reliable and reproducible, they must be obtained by precise, careful work. If the data are collected by several different persons, we must be sure that the technique is well standardized so that the results will be comparable.

Even when the technique is correctly employed, we must be cautious in interpreting the results. The distribution of fat stores may vary with age, and the results may be influenced by hypertrophied underlying muscle or by the presence of an oedema even an infra-clinical one.

The results are generally expressed in millimetres, most often as an average. We may also add up the different skin folds measurements for a same individual and consider the result as a new measurement, which will be expressed in the same way.

The study of the skin folds on the same individuals at regular intervals informs us on the accumulation or the reduction of subcutaneous fatty tissues. This finding may be most valuable in some situations, and especially for assessing the evolution of fatty tissue in women throughout pregnancy and lactation. When the measurements have been performed, the data are described, taking four factors into account : age, sex, place and time.

Example (1)

In Brazil, children living in the poor peri-urban areas (the favelas) have a less satisfactory nutritional status than those living in the heart of the city. Their ponderostatural growth is less rapid and their arm circumference, as well as their triceps skin fold, are smaller, on the average. In this study, the findings take the children's age and sex into account. For example : 12 year-old boys from the poor neighbourhoods have a triceps skin fold half as thick, on the average, as boys living in the heart of the city.

In Kivu (Zaire), this indicator of nutritional status is hardly used, for the following reasons :

---

(1) Desai, I.D., Garcia Tavares, M.L., Dutra de Oliveira, B.S., Desai, M.I., Cevallos Romero, L.S., Fichi, F.L., Duarte, F.A.M. and Dutra de Oliveira, J.E. Anthropometric and cycloergometric assessment of the nutritional status of the children of agricultural migrant workers in Southern Brazil. Am. J. clin. Nut., 34 : 1925-1934, 1981.

— the main nutritional problem in this region is a problem of protein deficiency. When a child, or a part of the population, suffers from protein-energy malnutrition, the protein component is predominant. This relativizes the value of measuring the skin fold ;

— in our approach, evaluation of the nutritional status of the population must be an ongoing process, and an integral part of the work of all health personnel, and this measurement is technically difficult to perform in a reliable, reproducible manner.

2.2 Clinical data

2.2.1. Description of the clinical signs

Clinical examination is a practical method, and an important one for evaluating nutritional status. The examination should be oriented toward the search for those clinical signs which are linked with energy and/or protein deficiency.

The advantages of such clinical examination are obvious : it is inexpensive, since it does not require complicated facilities, and may be performed by all members of the health team. However, some major difficulties should be mentioned :

— clinical signs are almost always unspecific. A marasmuslike appearance, for instance, may be caused by clinical infection, changes in the hair by zinc deficiency, changes in the skin to pellagra, oedemas to a kidney disease, hepatomegaly to parasitosis, diarrhoea to infections. In short, not only may the clinical signs observed in protein-energy malnutrition be caused by other, associated deficiencies, but they may also be linked with other environmental factors such as parasitoses and infections. Like the anthropometric signs, no single clinical sign is sufficient for a diagnosis, and it is only of value in combination with other findings ;

— clinical signs are generally not measurable. They may be observed, but the signs themselves and the investigation technique must be clearly defined if the observations made by various persons or by the same person at different times are to be comparable. As we describe these signs, we shall see that some are difficult to define accurately and their use should therefore be avoided. For the others, it is indispensable that all members of the health team working in a given region be trained to identify them by the use of the same criteria. To do so, the clinical signs must be perfectly defined, and all members of the health tema, those who work in the hospital as well as those in health centres or on surveys, must be trained to identify them. It is difficult in itself to assess a clinical sign, and the attempts to quantify the degree of severity of these signs are still more complicated : in addition, they are of no value. It is far preferable to limit ourselves to the distinction between "clinical sign present" and "clinical sign absent", which in itself is not that easy.

The main clinical signs of protein-energy malnutrition are as follows : marasmoid appearance, changes in the and the skin, oedemas, hepatomegaly, diarrhoea and behaviour disorders.

1) Marasmoid appearance

If the energy deficiency is considerable, the child or the adult looks thin, emaciated due to the decrease in subcutaneous fat and in muscle. In the extreme cases, the person may be bedridden. Expressions such as "skin on bones" or "marasmoid appea-

rance" are then used to describe this state. If the deficiency is mostly in proteins, the subcutaneous fatty tissue is well conserved and the children and adults do not seem thin.

Clinically speaking, if the state is extreme the sign is easy to observe and with no differences between members of the health team. On the other hand, the health team may differ in its assessment when emaciation is less severe, or moderate. In our approach, if we wish to establish a nutritional balance-sheet at the community level and to be able to compare it with others done subsequently, we need clinical signs which are always observed in the same manner by all. If the assessment of the sympton cannot be based on objective data, measurable whenever possible, it is preferable to use another symptom. Indeed, we would otherwise unnecessarily increase the time required for the examination, and would not arrive at an objective analysis of the situation, in any case.

In fact, the anthropometric measurements do enable us to quantify weight loss due to reduction in muscle and the disappearance of subcutaneous fatty tissue, especially if they are done repeatedly, and it is best to limit ourselves to these objective data.

2) Changes in the hair

These changes do not occur in marasmus, while in pure kwashiokor we may observe discolouration of the hair. Black hair may become white or red, and may also become more fine, thin, and change its shape (become strought).

There are many possible anomalies, and their extent is highly variable. The health team doing field work must therefore clearly define what is meant by discoloured or straightened hair. Some authors advise that use of the term "depigmented" be reserved for cases in which the entire scalp is affected. In our work, we decided to speak of depigmentation whenever it occurred, regardless of extent. This has two advantages :

— it avoids the difficulty of quantifying a clinical sign which is hard to measure but easy to observe ;
— it makes possible the clinical definition of the prevalence of moderate forms of protein-energy malnutrition, while other indicators may define the prevalence of more severs forms.

3) Changes in the skin.

These changes are not seen in marasmus. In pure kwashiorkor, on the other hand, pellagroid dermatosis occurs, and is not limited to the surfaces exposed to sunlight, as in true pellagra. This dermatosis is characterized by the following clinical signs (1) :

— hyperkeratosis : hyperpigmented areas becoming scaly and peeling easily occur in the pretibial area, on the forehead and the back ;
— non-inflammatory ulcerations ;

(1) Vis, H.L. Eléments de nutrition et de diététique. Presses Universitaires de Bruxelles. 1981. pp. 121 to 147.

— depigmented areas ;
— more or less extensive peeling, possibly producing the "flayed child" or "red child", as a red, exsudative derma is uncovered.

All of these changes are not always easily observable in an identical manner by all members of the health team. In our work, therefore, we have limited ourselves to the detection of depigmentation and peeling lesions only ; these lesions are generally easily identified by all team members. More thorough observations may of course be done when a health infrastructure is available, and they then provide complementary information on the diagnosis and the severity of protein-energy malnutrition.

4) Oedemas

Children with marasmus generally have no oedemas ; in pure kwashiorkor, on the other hand, these may be extensive, located on the face, the upper or lower limbs and the external genitalia. The presence of oedemas is confirmed by the pitting sign, a small depression produced by the pressure of a finger, and which subsists when the pressure is removed. The face has a typically moonlike appearance, or characteristically puffy cheeks, but does not pit on pressure. If the oedema is due to protein-energy malnutrition, it is generally bilateral. There is usually no ascitis or pleural effusion.

Within a health structure, the extent of the oedema may be ascertained, and a grading system found for the evaluation of its extension. During field surveys, however, it is mostly important to determine whether oedemas are present.

5) Enlarged liver (hepatomegaly)

In marasmus, the liver is generally not enlarged ; in kwashiorkor. On the other hand, steatosis causes hepatomegaly.

Practically speaking, the palpation of the abdomen must be done with the person lying down, hips and knees bent. When this position is respected, an enlarged liver may be detected by palpation, and its size noted. The latter is measured in centimetres below the rib edge, preferably on a line extending down from the nipple. However, this position is difficult to obtain when the examination is performed outside of a health infrastructure : at best, the child is examined while lying on his/her mother's lap. In addition, the differential diagnosis of palpable hepatomegaly is complicated, espacially in the tropics. These technical difficulties, added to the non specific nature of the symptom have led us to give up the routine search for the presence of hepatomegaly during field surveys for the evaluation of nutritional status.

6) Diarrhoea

In marasmus, atrophy of the intestinal mucosa may cause diarrhoea. In Kwashiorkor, such atrophy plus the absence of enzyme activities in the duodenum and the intestine may also cause diarrhoea and/or steatorrhoea.

It is easy to observe such diarrhoea in hospitalised children, but more difficult to do so during occasional surveys. We may of course question the person examined or accompanying the child, but responses are generally unreliable, and it is impossible to obtain accurate information. Field surveys therefore pay little attention to this question.

7) Behaviour disorders

In marasmus, children are generally anxious and ask for food, whereas children with kwashiorkor may be apathetic, withdrawn, saddand lacking interest in their environment and in food. As in the case of diarrhoea, these symptoms are easy to observe during prolonged surveillance, but difficult to detect when the examination is of limited duration, as is often the case during surveys. In addition, it is practically impossible to measure the extent of these behaviour disorders under ordinary circumstances. These symptoms are therefore not routinely recorded during field surveys.

2.2.2. Collecting, analysing, expressing and interpreting clinical data

Evaluation of the protein-energy nutritional status of the community requires a series of steps : collecting data, analysing them, expressing the results and interpreting these.

Like anthropometric data, clinical data should be collected routinely in the health structures. Every hospitalized person should receive a complete check-up for clinical signs of nutritional ailments, regardless of the cause of hospitalization. At health centres, the personnel should also adopt this attitude and record the presence or absence of clinical signs. If there is no clear note of the fact that a given sign was sought but not found, it is very difficult to analyse data, since the lack of information does not necessarily mean that the clinical sign is absent. Last, data should be collected regularly in the villages, outside of the health structures.

The data should be analysed at different levels : local, district, regional and national. This may be done quite simply, and locally, by the health personnel, but it may also be done with the help of micro-processors or computers, which require that the data be transcribed on to perforated cards. In the latter case, data analysis will be done very rapidly, but its programming, on the other hand, may require much time. Very gradually, alongside of the local analysis of data, we should attempt to achieve this computerization of data, since this would greatly facilitate the **ongoing evaluation** of the nutritional status of population groups.

For the clinical signs, the results are generally expressed in the form of figures on the frequency of each of the signs.

Example (1)

In recent years, a very high frequency of clinical signs of protein-energy malnutrition has been observed in children hospitalized in Iwiro (table 10). These children were hospitalized in the Medical department of the Institut de Recherche Scientifique (I.R.S., Kivu-Zaire), a hospital to which all of the nearby children are admitted, although its vocation is more specifically nutritional.

In addition, the results may be presented as a combination of the different indicators of protein-energy malnutrition.

---

(1) Unpublished findings, Hennart, Ph., Brasseur, D., Goset, Ch., Tshimpaka, K., CEMUBAC, 1983.

Table 10
Frequency of clinical signs observed in preschool-age children hospitalized in Lwiro in 1980 and 1981

Clinical signs observed (Number of patients : 963)	Percentage
Abnormal hair	67
Abnormal skin	38
Oedema	28

In addition the results may be presented as a combination of the different indicators of protein-energy malnutrition.

Example (1)

In 1977, we performed a survey to evaluate the nutritional status of the population in the region of Kabare (Kivu, Zaire). This survey, performed outside of the health structures, showed that a high percentage of the inhabitants showed clinical signs suggestive of protein deficiency. Table 11 presents the frequency of these signs in preschool-age children.

Table 11
Frequency of clinical signs of protein deficiency observed in preschool-age children in the region of Kabare (Kivu, Zaire)

Clinical signs observed (number of children examined : 365)	Percentage
Abnormal hair	47
Abnormal skin	9
Oedema	6
Only one sign	38
More than one sign	10

As we see, these findings clearly confirm the severity of the nutritional situation in this part of Zaire : this situation is constantly perceivable within the health structures (see previous example).

When data collection and analysis are over, the results are expressed in terms of the usual four factors : age, sex, place and time.

Age : the frequency of clinical signs of protein deficiency varies enormously with age. Indeed, kwashiorkor typically occurs when the child is weaned. The duration of

(1) Unpublished findings, Hennart, Ph., CEMUBAC, 1978.

breast-feeding is quite variable, and depends on the environment, customs, etc. (1) : age should therefore be taken into account. In addition, kwashiorkor may also occur in very young, breast-fed infants, and in adults : the description of these signs at different ages is quite important.

Example (2)

In the previous example, we have seen that clinical signs are frequent in pre-school-age children living in the region of Kabare (Kivu). If we class the data according to the age of the persons examined, including the older children, we find that the highest frequencies affect children aged 2 to 6 years, although the signs already exist in children under 2 (table 12). As for adults, we had discovered that 1 % of them showed one or several clinical signs of protein-energy malnutrition. Subsequent studies in this region confirmed the extent of this protein-energy malnutrition in children under 2 years old and in adults, especially women.

Table 12
Frequency of clinical signs of protein-energy malnutrition in the population of Kabare (Kivu).
Survey done in 1977 outside of all health structures

Age	Clinical signs observed (%)		
	abnormal hair	abnormal skin	oedema
0 - 1 (109)*	34	8	3
2 - 3 (139)	52	9	6
4 - 5 (117)	57	10	9
6 - 9 (136)	43	4	4
10 - 14 (87)	28	0	0
15 - 19 (49)	4	1	0

* Number of persons examined

Sex : in some regions, it may be of value to express the frequency of clinical signs in each sex. It is a fact that boys sometimes receive more consideration and care, and this may lead to a lower percentage of protein-energy malnutrition. In adults, the distinction between the sexes with respect to the frequency of clinical signs is a most important one, since the consequence for the family's health are not at all the same if it is the men or the women who are in a state of protein-energy malnutrition.

(1) Unpublished findings, Hennart, Ph., CEMUBAC, 1978.

(2) WHO. Contemporary patterns of breast-feeding. Geneva 1981.

Example

In southern Kivu, no sex-linked difference was found in the frequency of clinical signs in preschool-age children. In adults, on the other hand, women of age to procreate had a higher frequency of clinical signs of protein-energy malnutrition than men.

- **Place** : the frequency of clinical signs of protein-energy malnutrition varies considerably from one country to another. Within one country, major differences may occur, from one region to another and within the same region the populations of the different sub-regions do not have the same nutritional status. Many previously mentioned factors linked, to a great extent, to environmental differences, explain these differences in frequency.

Example (1)

A joint study was done in 1977-1978 in various regions of Zaire ; their objective was the definition of the extent of protein-energy malnutrition. These regions were : Ubangi (Gemena), Bas-Zaire (Kisantu) and Kivu (Kabare). The surveys were performed outside of all health structures. Table 13 shows the epidemiological findings obtained in 2 to 9 year-old children. Abnormal skin and oedema are seen to be much more frequent in Kabare than in the other regions.

Table 13
Frequency of clinical signs of protein-energy malnutrition in children aged 2 to 9 years, living in different regions of Zaire

	Clinical data observed in Zaire (%)		
	Ubangi (275)*	Bas-Zaire (978)	Kivu (586)
Abnormal skin	0.7	0	7.2
Oedema	1.8	0.5	9.0

* Number of persons examined

Table 14 (2) shows the frequency of clinical signs of proteins malnutrition in the population of Bukavu (urban area) and Kabare (rural area) in Kivu (Zaire). The examinations were performed outside of any health structure. We find that these clinical signs are far less frequent in the population of Bukavu than for people living in the

---

(1) Hennart, Ph., Bourdoux, P., Lagasse, R., Thilly, C.H., Putzeys, G., Courtois, P., Vis, H.L., Yunga, Y., Seghers, P., Delange, F. Epidemiology of goiter and malnutrition and dietary supplies of iodine thiocyanate and proteins in Bas-Zaire, Kivu and Ubangi. IN : Delange, F., Ieke, F.B., and Ermans, A.M. (Eds). Nutritional factors involved in the goitrogenic action of cassava. International Development Research Centre, Ottawa. IDRC 184th 1982 a. pp. 25-33.

(1) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

region of Kabare, despite the proximity of the two locations (± 15 km). The more satisfactory nutritional status of the city dwellers is partially explained by several factors : the possibility of a money income, a more varied diet, more satisfactory hygiene, less expenditure of energy.

Table 14
Frequency of clinical signs of protein-energy malnutrition
in the inhabitants of Bukavu (urban area) and Kabare (rural area)

	Clinical data observed in Kivu (%)	
	Bukavu	Kabare
Abnormal hair		
0 - 5 years	46.4 (261)*	55.6 (552)
6 - 14 years	15.4 (273)	48.1 (349)
15 years	1.2 (251)	6.0 (1,094)
Abnormal skin		
0 - 5 years	0 (261)	7.6 (551)
6 - 14 years	0 (273)	3.4 (348)
15 years	0 (250)	0.5 (1,096)
Oedema		
0 - 5 years	0.8 (260)	8.3 (351)
6 - 14 years	0 (273)	4.9 (348)
15 years	0 (251)	0.6 (1,096)

* Number of persons examined

Time : the frequency of clinical signs of protein-energy malnutrition may vary with the time of year in children of the same age living in the same region. Since most of these signs are essentially indicators of protein deficiency (oedema, changes in the skin and the hair, such variations mostly occur in the tropics, in groups living in a practically self-sufficient economy. Similarly, the frequency of the clinical signs seen in the health structures or outside of these may change as the years pass.

Once these data have been expressed, they must be interpreted. The problem of the interpretation of data will be discussed at greater length after the description of the biochemical data, since the evaluation of the nutritional status of population groups cannot be based on the interpretation of clinical data only. The diagnosis of a disease in an individual uses a combination of the case history and of anthropometric, clinical, radiological and biochemical data, and the same is true on the community level. None of the clinical data suffice for the accurate diagnosis of marasmus, for instance. In addition, the clinical indicators of kwashiorkor do not enable us to measure its extent. As we shall see subsequently, clinical signs may help us to evaluate the extent of protein malnutrition, but this interpretation of the data should be done with caution and be based on an in-depth analysis of the clinical, biochemical and anthropometric data

When these clinical signs are seen, however, be it within the health structures or outside of these, they should always be considered to be anomalies, suggestive of some hypotheses.

Example

In southern Kivu, the previously described examples show that the clinical signs of protein-energy malnutrition, and more specifically of its protein component, are frequently observed in patients hospitalized in the region. Field surveys have confirmed the high prevalence of these signs in rural Kabare. In urban area, on the other hand, skin anomalies and oedemas only occur in a small fraction of cases. Last, these data also show that the clinical signs may be seen in all of the rural population of Kabare, but that the highest frequencies are seen in 2 to 6 year-old children. These findings therefore suggest the existence of extensive protein deficiency in the rural area of Kabare, and more particularly among the 2 to 6 year-old children in that area.

2.3. Biochemical data

2.3.1. Description of the laboratory findings

Laboratory tests of nutritional interest may be performed on many tissue specimens, but in practice we generally analyse blood and urine. These laboratory tests are important, since they tell us much about protein nutrition, and more particularly whether the protein stores are exhausted and whether metabolic changes linked with tissue malnutrition have occurred. These tests raise the problems of specimen-taking, transportation, analysis and interpretation. Whenever possible, blood specimens should be taken from the fingertip ; this is feasible in case of microdosage. They must be kept in cold storage until they are examined, and the analysis must be done in a laboratory, which may be the basic laboratory for the region. This laboratory must use simple but reliable techniques, and the quality of the work should be checked at regular intervals. We may of course call upon the more efficient laboratories located in the capital or in other countries, but this type of collaboration should be reserved for complicated, expensive assays whose value to the population is less immediate. Last, the results should not be overly affected by recent intake of food and beverages, and should provide a complement to the anthropometric and clinical information.

Despite these disadvantages, a number of laboratory tests do provide most valuable information ; this is especially the case of the biochemical tests showing the protein component of nutritional status. As in the case of the clinical and anthropometric data, we shall not discuss the biochemical tests for the detection of deficiencies or overloads in vitamins or trace elements.

The main biochemical tests for protein-energy malnutrition are the dosage of serum proteins, free essential amino acids in the plasma, pancreatic enzymes and urinary excretion of hydroxyproline. In practice, dosage of serum albumin has many advantages : it is simple and easy to perform, since the total proteins may be measured in a small amount of serum, using a biuret technique, after which the dosage of serum albumin is done by electrophoresis on paper ; the blood may be taken from the fingertip. In addition, as we shall see in the chapter on analytic epidemiology, serum albumin is no doubt the most important indicator of the protein component of protein-energy malnutrition.

1) Serum proteins

The serum protein level is normal in marasmus. A drop in the level of serun proteins is quite characteristic of kwashiorkor, however, and this drop mostly affects those proteins produced by the liver : the albumins and lipoproteins. The concentration of total serum proteins is a poor indicator, since hyperglobulinaemia, caused by infections and above all by chronic malaria in the tropics, may mask a drop in serum albumin. Some authors especially recommend the dosage of prealbumin or of retinol-binding protein, both of which are also produced by the liver but have a very short half-life (several hours), whereas the half-life of albumin is approximately 18 to 20 days. Actually, the dosage of these different proteins may provide complementary information, since the prealbumin concentration, for example, is more easily influenced by the quality of the last meal, whereas the albumin concentration is a better indicator of the body's protein stores.

2) Free essential amino acids in the plasma

In case of marasmus, the level of the free essential amino acids in the plasma of the child with an empty stomach is normal, and the ratio of non-essential amino acids/essential amino acids is not modified. On the other hand, the level of free essential amino acids in the plasma of a child with protein malnutrition is diminished, and the above ratio is increased.

3) The pancreatic enzymes

They are normal in marasmus, while their activity is greatly decreased in kwashiorkor.

4) Urinary excretion of hydroxyproline

In undernourished children, the urinary excretion of hydroxyproline is decreased. The Whitehead index (1) is obtained by the use of a formula taking into account the correlation between hydroxyproline excretion and creatinine content per kilogramme of body weight. This ratio is lowered both in marasmus and in kwashiorkor.

2.3.2. Collection, analysis, expression and interpretation of biological data

Biological data should be collected routinely, when possible, within a reference hospital. Indeed, every reference hospital in a zone or region, should possess a basic laboratory capable of performing the simple, important biochemical tests. If it seems important to perform blood tests routinely on all hospitalized patients in the tropics, the dosage of serum albumin is equally important. If the laboratory tests performed in the hospital show that serum albumin levels are frequently low or more generally, if some signs suggest the possibility or protein deficiency in the region, dosage should be performed routinely during field surveys.

The analysis of the data should also be done at different levels and definitely at the basic laboratory level. Data processing is facilitated by the use of small adding

(1) Whitehead, R.G. (1965). Hydroxyproline creatinine ratio as an index of nutritional status and rate of growth. Lancet, 2, 567.

machines. For the biochemical data, the results are generally expressed in two complementary manners :

— as the average and the standard deviation from the average for the number of dosages perfomed. If the results are expressed in graph form, the average and standard error are generally indicated ;

— as the percentage of figures located above and below a given threshold.

Indeed, as we have already mentioned for the case of weight, the simple expression of the results as an average may hide the extent of some problems. The thresholds must be defined, whenever possible, on the basis of local experience and more specially with respect to the greater or lesser existence of a risk (see the chapter on analytic epidemiology). As usual, the results are expressed with respect to age, sex, place and time.

Age : serum albumin concentrations may vary with the age of the persons examined, since nutritional intakes and the influence of environmental factors may vary with age.

Example (1)

In 1973 and 1974, we examined nearly 3,000 people living in the rural area of Idjwi, in southern Kivu. These examinations took place of any health structure. Table

Table 15
Serum albumin concentration according to age.
Survey performed in Idjwi in 1973 and 1974
Average and standard deviation from the average

Age (years)	Serum albumin (g/dl)
0 - 1 (256)*	3.34 ± 0.58
2 - 3 (257)	3.16 ± 0.60
4 - 5 (235)	3.29 ± 0.58
6 - 9 (263)	3.28 ± 0.56
10 - 14 (268)	3.38 ± 0.60
15 - 19 (322)	3.62 ± 0.50
20 - 39 (616)	3.53 ± 0.59
40 - 59 (421)	3.50 ± 0.51
60 (106)	3.29 ± 0.56

* Number of persons examined.

NB : dosage of proteins was done according to Wolfon's method (1) and electrophoresis on paper according to Sonnet and Rodhain's method (2).

15 shows the average concentrations of serum albumin in the people examined, according to age. We find that the average concentration of serum albumin is lowest in 2 and 3 year-old children and highest in those aged 15 to 19.

(1) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

Sex : serum albumin levels must be expressed according to sex. Indeed, in children and in adults, food consumption may differ with sex. In addition, women of age to procreate who are regularly pregnant or lactation, have greater protein requirements.

Example (3)

During the same survey in Idjwi, we discovered that the average serum albumin concentrations were statistically identical in boys and girls in the same age group (figure 7). In adults aged 15 to 40, on the other hand, the average serum albumin concentrations are lower, to a statistically significant extent, in women than in men.

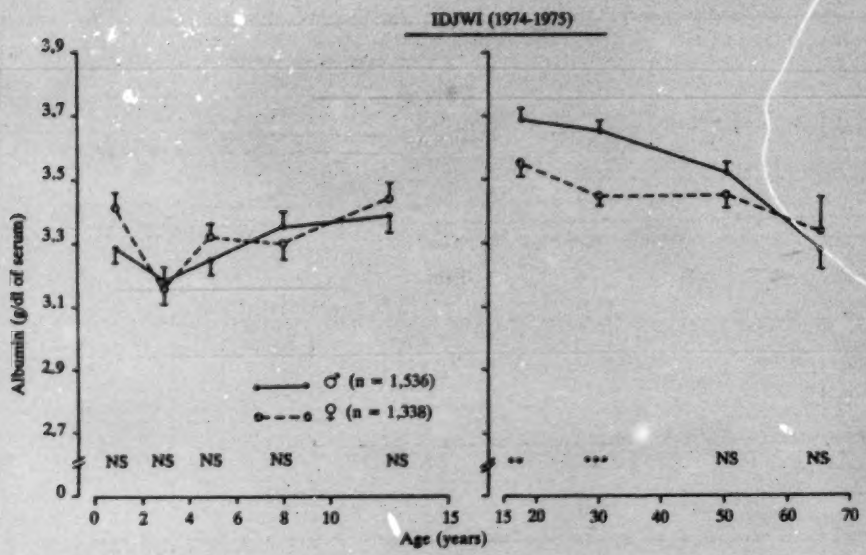

Figure 7 :
Comparison of serum albumin concentrations (g/dl) in people examined in Idjwi, according to age and sex. Average and standard deviation from average
Levels of significance : NS = Not Significant ; ** P = 0.01 or under ; *** P = 0.001 or under Same method of measurement as described above.

---

(1) Wolfson, W.Q., Cohn, C., Calvary, E. and Ichiba, F. Studies in serum proteins ; V. : A rapid procedure for the estimation of total protein, true albumin, total globulin, alphaglobulin, betaglobulin and gammaglobulin in 1.0 ml of serum. Am. J. Clin. Pathol. 1948 ; 18 : 723-730.

(2) Sonnet, J. and Rodhain, J. Etudes des protéines sériques par l'électrophorèse sur papier. I : Techniques et résultats normaux. Rev. Belge Pathol. 1952 ; 22 : 226-240.

(3) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

Place : within a same region, the various factors which may influence the serum albumin concentration of the population vary considerably. Protein intakes, food habits, the duration of breast-feeding and still other factors to be described below often differ between urban and rural areas and within these areas, between the different sub-regions.

Example (1)

In southern Kivu, we do nutritional surveys outside of the health structures every year. In 1977, we went to the region of Kabare, a rural area close to the city of Bukavu. The clinical examination of the population revealed that clinical signs of protein malnutriton were far more frequent than in Idjwi, for instance, another rural area, or in Bukavu, an urban area (see above). The biochemical data confirm this clinical impression, since the percentage of inhabitants with a low serum albumin concentration (below 2.5 g/dl) is higher in Kabare than in Idjwi (table 16).

Table 16
Percentage of individuals with a serum albumin concentration below 2.5 g/dl in the rural areas of Idjwi and Kabare.
Identical dosage methods

Age (years)	Serum albumin concentration below 2.5 g/dl (%)	
	Idjwi (rural area)	Kabare (rural area)
0 - 1	7 (258)*	10 (81)
2 - 3	14 (257)	21 (111)
4 - 5	8 (236)	23 (92)
6 - 9	9 (262)	16 (107)
10 - 14	8 (267)	4 (75)
15 - 19	2 (322)	2 (43)
20 - 39	4 (614)	5 (231)
40 - 59	3 (421)	4 (111)
60 and over	6 (105)	5 (73)

* Number of persons examined

Time : like the clinical indicators of protein-energy malnutrition, serum albumin concentration may show seasonal fluctuations within the course of a year. This is particularly true in the tropics, where money income is meager, storage techniques unsophisticated and dietary protein intake is mostly linked with farming. Under these conditions, dietary protein intake fluctuates in the course of the year, depending on the growing and harvesting periods of cereal grains and/or legumes.

If the nutritional situation improves or deteriorates over time, the serum albumin concentrations of the inhabitants of a region may also rise or fall.

---

(3) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

Example (1)

In southern Kivu, surveys on dietary consumption in rural areas, particularly in Idjwi, have shown that protein intake is lowest during the period before harvesting of protein crops ; that is, in September/October/November (2). The surveys for the evaluation of nutritional status done in Idjwi also show that the serum albumin concentrations are much lower in preschool-age children during the period before protein crops are harvested (figure 8). This difference is highly significant for the 2 and 3 year-old group. The concentrations remain unchanged in older children, then drop again in 40 to 60 year-old adults at the same time of year. Thus, protein malnutrition, the most frequent form in this region, varies with the seasons.

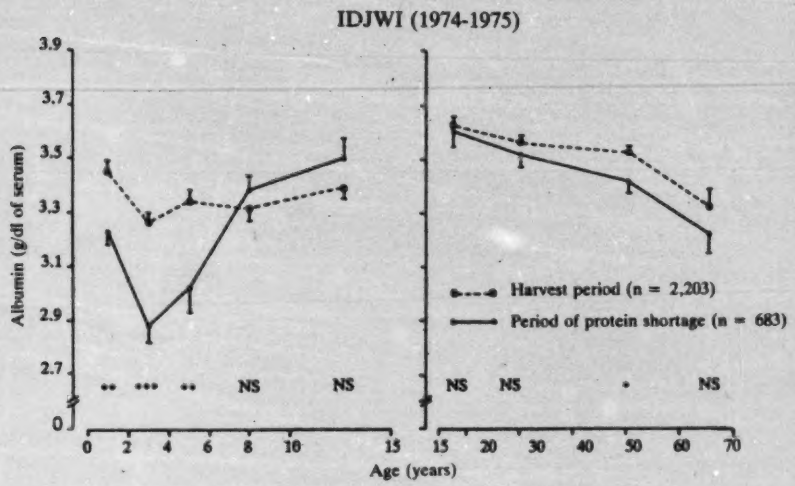

Figure 8 :
Serum albumin concentrations according to age
and time of year for the population of Idjwi
Average ± standard deviation from average
Levels of significance : NS = Not Significant ; * P = 0.05 or under ;
** P = 0.01 or under ; *** P = 0.001 or under

(1) Report on the activities of the CEMUBAC medical mission to the Zaire Republic, and more specially at the I.R.S. medical department and the rural hospitals of Kirotshe, Masisi and Rutshuru, published each year.

(2) Vis, H.L., Pourbaix, Ph., Thilly, C. and Van Der Borght, H. Analyse de la situation nutritionnelle de sociétés traditionnelles de la région du lac Kivu : les Shi et les Havu. Enquête de consommation alimentaire. Ann. Soc. Belg. Med. Trop. 1969 ; 49 : 353-419.

We must be cautious in interpreting biochemical test results separately. Specimen-taking, transportation and analysis techniques must be correct. Next, a drop in the serum albumin concentration within a community does not necessarily mean that protein intake has dropped : other causes may be at work, such as poor assimilation, infections and parasitoses. Last, some situations lead to an improper interpretation of the data ; these include haemodilution during pregnancy or haemoconcentration during dehydration. Biochemical tests should therefore be interpreted in conjunction with clinical and anthropometric data.

We have already provided a very general description - for weight, for instance - of the different steps to be followed in the interpretation and use of all of these data. The main points are as follows :

— description of the nutritional status of a population group in a region at a given time. This description should be based upon data collected outside of the health structures, but should integrate the data collected within these structures ;

— comparison of the nutritional assessment of a community living in one region with the nutritional status of another community living in another region. This comparison may be done on a regional, national or international level. For instance, it may be valuable to compare the nutritional status of inhabitants of a rural area with that of city dwellers in the same region. It is also quite instructive to compare the nutritional status of population groups living in the developing countries with those living in industrialized countries :

— comparison of this nutritional assessment with an identical one established previously for the same community. This comparison is rarely immediately feasible, since no initial nutritional assessment is available, but it should therefore be established as soon as possible, for subsequent comparisons ;

— last, the nutritional assessment drawn up within and outside of the health structures should be the point of departure for studies aimed at determining the risk factors for the health and nutritional status of members of the community, after which high-risk individuals may be identified. Only this approach enables us to define the community's needs and the top priority actions.

3. Some special groups

While we may describe the nutritional status of the community as a whole with the use of the previously defined indicators, some groups within this community should be given special attention. The most important of these are definitely pregnant women, lactating women and newborns.

In some parts of the world, and quite generally in the tropical countries, women constantly have increased nutritional requirements. Indeed, during their fertile years, they are often - if not continuously - either pregnant or lactating. Women are therefore vulnerable to nutritional problems. In addition, the nutritional status of pregnant and lactating women influences the nutritional stauts of small children ; for this reason it must be accurately assessed. Last, the nutritional status of newborns must be carefully described for the following reasons ; it represents an indicator of the nutritional status of pregnant women, provides precious information on a long period of life, stretching back some 9 months, and also contributes to the accurate estimation of the

child's chances of survival and of having satisfactory ponderostatural growth. As we see, the evaluation of the nutritional status of these three groups is inter-related and represents an indispensable first step in the evaluation of the nutritional status of the population groups within a region.

This chapter will not repeat the description of the above-mentioned indicators, which remain valid, on the whole, but it will emphasize some important points specific to these particular groups.

3.1. Pregnant women

While the nutritional status of pregnant women at a given point in pregnancy should be defined, using the indicators described above, it is even more important to follow the changes in nutritional status in the course of pregnancy : the average weight of the foetus depends on a number of factors, including the mother's weight gain during pregnancy.

In the industrialized countries, pregnant women have gained an average of 4 kg at 20 weeks and 12.5 kg at term. When they leave the hospital after childbirth, they weigh 4.4 kg more than before their pregnancy, on the average ; this excess weight will be lost gradually, particularly by those who breast-feed their child. Table 17 shows the distribution of this weight gain during pregnancy, according to Hytten and Leitch (1).

Table 17
Weight gain during pregnancy
(increase in weight in grammes, until the 40th week)

Fœtus	3,400
Placenta	650
Amniotic fluid	800
Uterus	970
Mammary glands	405
Mother's blood	1,250
Extracellular and extravascular fluid	
a) no oedema or on legs only	1,680
b) systemic oedemas	4,897
Other gains	
a) no oedema or on legs only	3,345 fat stores
b) systemic oedemas	2,128
Total weight gain	
a) no oedema or on limbs (legs) only	12,500
b) systemic oedemas	14,500

(1) Hytten, F.E., Leitch, I. (1971). The physiological of human pregnancy. Blackwell Scientific Publications. Oxford, London and Edinburgh (Great Britain).

This table shows us that :

— part of women's weight gain is due to the storage of fats ; these fat stores represent a source of energey for lactation. Anthropometric indicators such as skin folds, arm and thigh circumference and weigh, of course, when measured at regular intervals during pregnancy, show the extent of weight gain and of fat storage ;

— the mother's blood increases in volume during pregnancy. Some indicators such as the serum albumin concentration may therefore be lower simply because of haemodilution, and not necessarily because of depletion ;

— the child's weight at birth may represent an indicator of weight gain and thus of the woman's nutritional status during pregnancy. The same is true of the weight of the placenta. At the community level, data collection in maternity wards and, whenever possible, at all deliveries, is very important.

In the developing countries, and especially in the tropics, pregnant women may gain very little weight, sometimes no more than 4 or 5 kg. This decreased weight gain leads to a lower placental weight and a lower birth weight for the baby.

Example

In one rural area in southern Kivu, women rarely gain more than 5 to 6 kg during pregnancy. Under these conditions, the weights of the placenta and of the newborn are lower than in the industrialized countries. Indeed, in 1982, the average placental weight ranged from 540 to 570 g and that of newborns from 2,800 to 2,900 kg (table 18).

Table 18
Average weight of placentas and newborns in different maternity wards in southern Kivu en 1982

	Kirotshe	Rutshuru	Masisi
Weight of placenta (g)	567 ± 120 (460)	556 ± 96 (519)	547 ± 113 (420)
Weight of newborn (kg)	2.90 ± 0.46 (635)	2.88 ± 0.47 (521)	2.89 ± 0.49 (425)

While anthropometric data mostly informs us of the energy component of protein-energy malnutrition in pregnant women in the tropics, clinical signs and above all, the serum albumin concentration, should tell us the extent of the protein component of this malnutrition. Indeed, in those regions where the diet is deficient in high-quality proteins, where kwashiorkor is the most frequently encountered type of malnutrition, and where clinical signs such as discoloured hair for example are also observed in

adults, we may expect to find low serum albumin concentrations in pregnant women. Our experience in rural southern Kivu shows this to be a fact, but this drop in serum albumin concentration during pregnancy remains quite comparable to that seen in the industrialized countries (figure 9).

Given the weight gain of pregnant women in this region of Kivu, we may reasonably deduce that this drop in the serum albumin concentration corresponds to a depletion in serum albumin, but the measurement of this concentration only does not

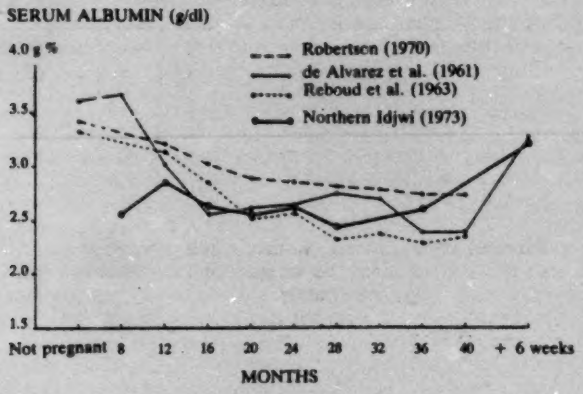

Figure 9 :
Evolution of average serum albumin concentrations in women during pregnancy, in Kivu (Idjwi) and in industrialized countries (1)

enable us to differentiate between a phenomenon linked to blood depletion and one linked to haemodilution. We may differentiate normal pregnancy from kwashiorkor by measuring the blood lipids (cholesterol, triglycerides, phospholipids), which are low in kwashiorkor and high in pregnant women.

---

(1) Robertson, E.G. (1970). The national history and physiology of oedema occuring during pregnancy. M.D. Thesis, University of Newcastle-upon-Tyne.

De Alvarez, R.R., Afonso, J.F. and Sherrard, D.J. (1961). Serum protein fractionation in normal pregnancy. Am. J. Obst. Gynec. 82 : 1096

Reboud, P., Groulade, J., Groslambert, P. and Colomb, M. (1963). The influence of normal pregnancy and the postpartum state on plasma proteins and lipids. Am. J. Obst. Gynec., 86 : 820.

Despite the difficulties in proper assessment, it is quite important to determine the severity of protein malnutrition in pregnant women, for it may also cause foetal malnutrition. One indirect way of evaluating malnutrition may be the measurement of serum albumin in the lactating woman during the first days of post-partum. Such an approach has shown that in India, mothers of children born at term with a very low average weight ($\bar{m}$ = 1.614 kg) had a much lower average serum albumin concentration ($\bar{m}$ = 2.65 g/dl) than those whose children had a normal average birth weight for the region ($\bar{m}$ = 2.841 kg) and whose average serum albumin concentration was usual for the region ($\bar{m}$ = 3.40 g/dl) (1).

Data on pregnant women should be collected, analysed, expressed and interpreted according to the same methodology as described above. Prenatal consultations and maternity departments in reference hospitals and health centres should be used for routine collection of these data.

Example

In recent years, the health team in the mountainous part of Kivu has collected some data for all women entering the maternity ward. Following a one-year trial period needed for the standardization of methods and for drawing the attention of health workers to the question, a number of data are now collected routinely, and an assessment is made at the end of each year. The data are : date of admission to the maternity ward, mother's age, ethnic group, place of origin, mother and father's educational level, number of pregnancies, number of living children, date of birth of the previous child, mother's weight at entrance, her height, circumference of the left arm, any pathology seen in the woman, date of childbirth, presentation, any obstetrical pathology, type of delivery, weight of placenta, anthropometric data for the newborn and mother's weight when leaving the hospital. With the simple description of the nutritional status of the mother before and after delivery and of the newborn, these data also make it possible to analyse the risk factors for death of the mother and the child during childbirth and the ensuing 7 days.

Short-term surveys will be done in the villages, outside of the health structures, in order to complete the basic data collected in the health structures and to make sure that these are comparable to the other figures and thus truly representative of all of the pregnant women in the region.

Once the data has been collected and analysed, the results are expressed with respect to the usual factors : age, place and time, to which the length of gestation is added, when possible. The date of the last menstruation may be used to evaluate the latter, and/or, retrospectively, the clinical and neurological examination of the newborn. Regardless of the method used, it is a fact that the latter evalutation is usually imprecise. The accuracy and value of the data may be improved if they are collected during longitudinal studies pursued up to childbirth.

---

(1) Bhargava, S.K., Bhargava, U., Kumari, S., Bhargava, N., Ghosh, S. (1983). Maternal nutrition and fetal growth retardation. J. Trop. Pediatr., 29 : 148-150.

3.2. Lactating women

The indicators described above may be used to evaluate the nutritional status of lactating women. The energy component of protein-energy nutritional status is mostly evaluated by anthropometric indicators such as weight, height, arm and thigh circumference. Quetelet's index, which is the weight/height^2 should be added to this. It improves the assessment of the degree of overweight or of undernourishment in adults, given their height. Biological dosages such as the cholesterol level will complete this assessment.

The protein component depends on the presence or absence of the characteristic clinical signs and above all by the dosage of serum albumin. As in children, the serum albumin concentration seems to be the major indicator, and should be measured routinely when possible. In southern Kivu we have discovered that lactating women in rural areas are relatively deficient in proteins in comparison with urban women, and under these conditions abnormal hair is the only discriminative clinical sign between the two groups. Table 19 shows that this clinical sign is actually linked with a less satisfactory overall nutritional status, caused by various deficiencies, but it does not seem to be very specific of protein deficiency (1).

Table 19
Biological and anthropometric data in lactating women in a rural area with or without abnormal hair upon clinical examination
Average ± standard deviation

	Abnormal hair		
	NO	YES	t test
Serum proteins (g/dl)	6.89 ± 1.06 (612)*	6.79 ± 0.86 (85)	1.02 NS
Serum albumin (g/dl)	3.03 ± 0.57 (612)	2.92 ± 0.51 (85)	1.69 NS
Weight (kg)	51.3 ± 0.6 (625)	47.0 ± 0.5 (90)	5.99***
Weight/height^2 (kg/m^2)	20.7 ± 2.6 (625)	19.4 ± 2.1 (90)	4.94***
Arm circumference (cm)	24.7 ± 2.0 (626)	23.3 ± 1.9 (90)	6.01***
Thigh circumference (cm)	45.9 ± 3.8 (518)	43.4 ± 3.5 (88)	5.87***
Cholesterol (mg/dl)	149 ± 44 (302)	117 ± 38 (28)	3.62***

NB : the figures in parentheses represent the number of persons examined.
N.S. = Not Significant ; * punder 0.5 ; *** punder 0.001.

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

If the data are collected during simple cross-sectional studies, the mothers are only examined once, and the results provide a picture of the nutritional status of lactating women at a given moment in post-partum. As for children, however, it is even more important to follow the changes in mothers'nutritional status throughout the lactation period ; this means that the nutritional status and, if possible, the nutritional situation, of the mother should be examined in a much more dynamic manner. Such a follow-up provides information on the use of any energy reserves built up during pregnancy. In the industrialized countries, for instance, lactating women use their energy reserves and the anthropometric indicators reflect this consumption of fat : their weight decreases gradually and the evolution of the skin folds shows that this weight loss occurs to the detriment of the fatty tissue. This may also occur in the developing countries.

Example

In Guatemala, Schutz et al. (1) did a longitudinal study which revealed that lactating women in rural areas lose an average of 369 g per month following parturition, whereas non-lactating women lose 10 times less weight during the same time (35 g per month). This weight loss is caused by a loss of fatty tissue (decreased skin folds) rather than a loss of water. In this region, lactating women responded to their increased nutritional requirements linked to lactation by drawing on their fat stores, without increasing their dietary intake or decreasing their expenditure of energy.

However, in the tropics, we way find that the various anthropometric indicators do not vary, since the reserves accumulated during pregnancy are very small and sometimes nil. In this case, lactating women may maintain a relative nutritional balance, to the detriment of the amount of milk secreted, for instance (2).

Example

Table 20 shows the anthropometric characteristics of lactating women in the rural area of Kabare (Kivu, Zaire), according to the age of the breast-fed child. These data were collected during a cross-sectional study done outside of any health structure. No statistically significant variation in the anthropometric indicators was found in this area with respect to the duration of post-partum. It is true that in this area the nutritional situation is critical, and mothers practically never accumulate any energy reserves during pregnancy.

Only the description of all of these indicators and of their evolution in the course of lactation and even, when possible, during the pregnancy which preceded lactation enables us to describe the nutritional situation of lactating women. Last, the simple comparison of the nutritional status of lactating women and of those who are neither pregnant nor lactating may provide valuable information and suggest a number of remarks and attitudes.

---

(1) Schutz, Y., Lechtig, A. and Bradfield, R.B. (1980). Energy expenditures and food intakes of lactating women in Guatemala. Am. J. Clin. Nutr., 33 : 892-902.

(2) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

Table 20
Anthropometric characteristics of lactating women in rural Kabare according to the age of the breast-fed child
Average ± standard deviation

Child's age (months)	Weight/height^2 (kg/m^2)	Arm circumference (cm)	Thigh circumference (cm)
0 - 2	20.7 ± 2.3 (123)*	24.3 ± 1.9 (122)	45.5 ± 3.4 (103)
3 - 5	20.6 ± 2.3 (144)	24.5 ± 2.1 (146)	45.4 ± 3.6 (126)
6 - 8	20.7 ± 2.1 (88)	24.6 ± 2.1 (88)	46.0 ± 4.1 (76)
9 - 11	20.6 ± 2.2 (92)	24.7 ± 2.2 (92)	45.9 ± 3.8 (76)
12 - 14	20.8 ± 2.3 (91)	25.0 ± 2.0 (91)	46.0 ± 4.1 (76)
15 - 17	20.4 ± 2.5 (63)	24.8 ± 2.4 (63)	46.0 ± 4.2 (55)
18 - 23	20.1 ± 1.9 (74)	24.3 ± 2.1 (74)	44.6 ± 4.0 (62)
24 and over	20.4 ± 2.1 (46)	24.5 ± 2.2 (46)	45.1 ± 4.4 (38)
F test	0.81 NS	1.09 NS	1.11 NS

* Number of persons examined
N.S. = Not Significant

Example (1)

Table 21 compares the serum albumin concentrations of women aged 15 to 49 years living in southern Kivu, in an urban area (Bukavu) and in rural areas (Idjwi and Kabare). The women are divided into three groups : not pregnant and not lactating, lactating, pregnant.

In each of these three regions, pregnant women have lower serum albumin concentrations than non pregnant, non lactating women. However, these concentrations are identical in lactating women and non pregnant, non lactating women, except in Kabare, where they are significantly lower in lactating women (3.16 g/dl) than in non pregnant, non lactating women (3.30 g/dl, t test = 2.90 ; P is 0.01 or under). If the albumin concentrations in these three regions are compared for each of the three groups of women, they are found to be identical in Bukavu and Idjwi, but significantly much lower in Kabare. In other words, the nutritional status of fertile women in

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 183.

Kabare is worse than that of women from Bukavu, and in the Kabare region, lactating women have a less satisfactory nutritional situation than non pregnant, non lactating women.

In this study, the women were examined in the course of cross-sectional studies done outside of any health structure. The duration of gestation or of post-partum was not taken into account in the expression of the results. This omission is less serious for the analysis of serum albumin concentrations in lactating women, since we have seen that in this region, the average serum albumin concentrations hardly vary during the post-partum period (1).

Table 21
Comparison of serum albumin concentrations in women aged 15 to 49 years in Bukavu, Idjwi and Kabare.
Average ± standard deviation

Serum albumin (g/dl)	Bukavu	Idjwi	Kabare
Non pregnant, non lactating	3.66 ± 0.47 (33)	3.59 ± 0.46 NS (203)	3.30 ± 0.36*** (110)
Lactating	3.64 ± 0.55 (88)	3.55 ± 0.52 NS (232)	3.16 ± 0.47*** (193)
Pregnant	3.25 ± 0.43 (31)	3.15 ± 0.50 NS (77)	3.05 ± 0.36* (46)
F test	7.5***	22.8***	6.8***

NB : The figures in parentheses represent the number of women. The significance levels refer to the results obtained in Bukavu. N.S. = Not Significant ; * P under 0.05 ; ** P under 0.01 ; *** P under 0.001.
The F test compares the results found in the three groups of women for each region. Significance level : *** P under 0.001.

The methodology for collecting, analysing, expressing and interpreting data is the same as described above. The evolution of mothers nutritional status may be observed when cross-sectional studies perform repeated examinations, seeing the same women on several occasions during the post-partum period, or when simple cross-sectional studies cover a great many women who are at different points of post-partum. The latter method may show some trends in the evolution of indicators of the nutritional status of women in the course of lactation, but the results should always be interpreted with caution. We must be sure that the lactating women observed at different points of post-partum are truly representative of women in the region, and have comparable socio-economic characteristics. If possible, the results of such studies should be confirmed or disproved by longitudinal studies of a smaller sample of mothers.

---

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

Infant consultations are particularly good places for such observations, but unfortunately quite frequently only the child is examined, with no attention being paid to the mother's nutritional status. In addition, occasional surveys should be done from time to time in the villages, outside of any health structure. Once the data has been collected and analysed, the results are expressed with respect to the usual factors, mother's age, place and time, to which the duration of post-partum shoud be added. Since we have already given examples for the post-partum period and the place, we shall only describe the possible importance of the mother's age and the time.

The mother's age : the frequency of signs of the mother's protein-energy nutritional status may possibly vary with age, and this should be taken into account. In fertile women, at least in the tropics, where fertility is natural, the mother's age is closely correlated with the number of pregnancies, and it may be difficult to distinguish between these two aspects. In fact, this distinction is often of theoretical interest only.

Example (1)

In our cross-sectional surveys done in urban and rural parts of southern Kivu, we found that the weight/height^2 ratio of lactating women dit not vary greatly with age or parity (table 22). The same is true for serum albumin concentrations.

Table 22
Weight/height^2 ratio according to the age and parity of lactating urban and rural women.
Average ± standard deviation

Weight/height^2 (kg/m^2)	Urban area	Rural area
AGE		
• under 24 years	23.3 ± 2.8 (474)	20.7 ± 2.1 (232)
• 25 to 34 years	23.8 ± 3.2 (195)	20.4 ± 2.1 (314)
• 35 years or more	23.0 ± 3.2 (45)	20.5 ± 2.3 (175)
F test	2.86 NS	0.11 NS
PARITY		
• 1	23.0 ± 2.6 (218)	20.7 ± 2.1 (89)
• 2 -3 - 4	23.6 ± 3.2 (286)	20.6 ± 2.1 (270)
• 5 and more	23.5 ± 2.7 (226)	20.4 ± 2.2 (362)
F test	3.62*	0.64 NS

NB : the figures in parentheses show the number of women. Levels of signifiance : NS = Not Significant, * P under 0.5

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

Time : the nutritional status of lactating women may show seasonal fluctuations in the course of the year. Such variations are shown by the indicators of the protein and/or energy components, depending on the type of deficiency present in the area.

Example (1)

In mountainous, rural Kivu, the diet is composed of four staple foods : beans, sweet potatoes, manioc and bananas, as well as banana beer. The family's fields furnish almost all of its food products, and there are practically no reserves, since storage techniques are unsophisticated. We may therefore predict, theoretically, the annual periods of abundance and dearth by reading the agricultural calendar. The first months of the rainy season (September, October and November) represent the difficult period.

While the energy intake shows little seasonal variation because manioc and sweet potatoes can be harvested regularly, the same is not true for protein intakes, which depend mainly on the beans, for which seasonal variations exist. The period of protein shortage corresponds to the period before the beans are harvested : September, October and November.

Under these conditions, surveys performed outside of the health structures show that the nutritional status of lactating women experiences seasonal variations. Although their weight/height^2 ratio is relatively stable during the different seasons (since the energy intake is quite stable), the serum albumin concentrations fall dramatically during the protein shortage period (table 23).

Table 23
Weight/height^2 and serum albumin in lactating rural and urban women, at different seasons
Average ± standard deviation

Month of the year	Weight/height^2 (kg/m^2)	Serum albumin (g/dl)
December - January - February	21.0 ± 2.3 (157)*	3.32 ± 0.40 (153)
March - April - May	20.4 ± 1.8 (150)	3.16 ± 0.55 (146)
June - July - August	20.4 ± 2.0 (95)	3.17 ± 0.33 (90)
September - October - November	20.4 ± 2.3 (319)	2.77 ± 0.58 (313)
F test	3.89**	46.42***

* Number of persons examined

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

The test results (analysis of covariance) are adjusted for the age of the breast-fed child. Levels of significance = ** P under 0.01 ; *** P under 0.001.

If the nutritional situation within a region improves or deteriorates over a period of time, the nutritional status of lactating women may also be modified. Caution must be used in interpreting all of these findings. As for children, the biochemical test results cannot be separated from the clinical and anthropometric data, and the correct description of the mothers'nutritional status must be based on the analysis of all of these data. Last, we must remember that the causes and effects of the different nutritional statuses cannot yet be deduced, at this stage of our approach. This will be the subject of the forthcoming chapters.

3.3. Newborns

Although the evaluation of the nutritional status of newborns scarcely differs from that of older children, it is important to place emphasis on this group, since it cannot be separated from the evaluation of the nutritional status of pregnant women and subsequently of the lactating woman, nor from that of young children.

For it is a fact that when the child is born, he/she has already lived a very important period, which may condition the rest of his/her life, and especially his/her chances of survival and height and weight growth. During foetal life and until birth, foetal life is quite dependent upon the nutritional status and health of the mother. Now, this is a crucial period in the life of all children, since it corresponds to the phase of cell multiplication and more specially, multiplication of the brain tissue. This phase may of course continue after birth, for a very limited period of time, for some tissues (± 2 years for brain tissue) or for a longer period of time for others until adolescence for the bone and muscle tissues, for example), but after birth the tissues mostly develop by cellular hypertrophy. This period of organ development through cell division is therefore fundamental, since it conditions the number of cells finally present.

The foetal height increases most rapidly during the period between 3 and 6 months of foetal life, whereas it is mostly during the last month of the pregnancy that the foetal weight tends to double. At this stage, the uterine cavity represents a restrictive factor, of sorts, which moderately limits growth. Similarly, placental growth is at a peak after 38 to 40 weeks of gestation [illegible]t signs of deterioration may occur if the gestation exceeds 41 weeks, and this w[illegible]nally influence the foetal cell development and weight growth.

The evaluation of the nutritional status of the newborn is in reality an integral part of the evaluation of the nutritional and health status of the mother, since the relations between the two are extremely important, as we shall see. The newborn's almost total dependency upon the mother lasts quite a while, since the nutritional status of the young breast-fed child also depends upon the health and nutritional status of the lactating mother.

This evaluation is important since it is clearly proved, throughout the world, that there is a close correlation between low birth weight and mortality. This will be discussed later, in the chapters devoted to analytic epidemiology, but we all know, by our personal experience in field work, that children with a low weight at birth have much lower chances of surviving the critical neonatal and post-natal periods, and that those who survive have greater chances of showing retarded height and weight growth, for example.

The indicators of the newborn's protein-energy nutritional status are no different from those described above. In practice, emphasis is mostly placed upon anthropometric data and more particularly upon weight, height and arm circumference.

The method of collecting, analysing, expressing and interpreting the data collected in newborns is the same as for the other groups. Maternity units are of course the best places for collecting such data, but similar data on children born at home must of course be obtained. In this respect, **arm circumference** is a particularly valuable nutritional indicator (1).

The results are expressed, as usual, according to gestational age, sex, place and time. Although this is not always easy, an attempt must be made to determine the infant's gestational age on the basis of the last menstruation and this age should be confirmed by the physical and neurological examination of the child. It is important to evaluate the gestational age, since it is clearly proved that a child born at term with a low birth weight has a less satisfactory height and weight growth than a preterm infant with an equally low birth weight.

---

(1) De Vaquera, M.V., Townsend, J.W., Arroyo, J.J. and Lechtig, A. (1983). The relationship between arm circumference at birth and early mortality. J. Trop. Pediatrics, 29 : 167-174.

II. DECISIVE FACTORS IN THE COLLECTIVE PROTEIN-ENERGY NUTRITIONAL STATUS

The clinical experience of people faced concretely with the problems of malnutrition and overnourishment, the epidemiological studies and more fundamental aetiological research have brought to light a number of factors which influence the protein-energy nutritional status of a part of or an entire population group.

We do not intend to present an exhaustive list of these factors, but to describe those which it is important to know in order to properly describe and analyse variations in the nutritional status of the members of a community.

Not all cases of malnutrition are caused by these factors : many other causes exist, known or still to be discovered. In addition, the relative importance of these various factors may be extremely variable depending upon the genetic potential, the environment and the behaviour of the different communities. They nonetheless represent, in our opinion, some basic elements which must be assessed if a health team is to undertake actions and preventive programmes within a community, and be equipped to evaluate such programmes.

A variety of methods must be used to describe these different factors. For each one, we must therefore describe the method used for the collection, analysis, expression and interpretation of the data. These will be systematically expressed with respect to age, sex, time and place.

In this discussion, we will limit ourselves to the description of the most important factors and illustrate the method used and the data obtained by our team in Central Africa by several examples. We have voluntarily simplified the description of our approach, but the reader must remember that in reality the factors exist conjointly, with many, complicated inter relations between them. If the health of the lactating woman may influence the nutritional status of the breast-fed child, for instance, the latter may also affect the mother and modify her behaviour as well as her health status.

1. Personal factors

1.1. Dietary intake (including breast milk)

Numerous studies throughout the world have shown that diet deeply influences people's nutritional status and, more generally, their health. The family diet, and that of each individual within the family, therefore influences the nutritional status of each member of the family. If we are to understand the nutritional situation of an individual and/or a group of people living in a given region, we must therefore perform dietary surveys.

Dietary surveys are used to determine how people eat ; their methodology depends on their objective, and the term "consumption survey" is generally used if the aim is to determine the qualitative and quantitative food consumption, while "motivation surveys" designates the investigation of the conscious and unconscious factors influencing this food consumption (1).

The techniques for dietary surveys are few in number, and none is perfect. Consumption surveys based on questioning about the food eaten the day before, in terms of quality and quantity, and surveys using weighing during a 7-day period are most frequently used. Both provide precise information on the calories and the nutrients consumed, as well as on the proportion of each type of food and on how they alternate within meals. In addition, qualitative analyses are often needed in order to define the amount of nutrients contained in the food.

Each method has its advantages and disadvantages, and the validity of the results is a complex question which receives thorough study elsewhere (2).

Like other survey results, these results are expressed in numerical form ; the figures are calculated in absolute terms and/or as a relative proportion of international norms. They are also used to describe the types of dietary behaviour. The four major factors, age, sex, place and time are taken into account in the expression of the results.

Example

Surveys on breast-feeding are more specific but extremely important. Indeed, although breast-feeding is gradually regressing in the developing countries, breast-milk is still usually the first food consumed by newborns. Gradually, and sometimes rapidly, children are given complemental foods and when weaned they share the family dish. Actually, the decrease in breast-feeding observed in many parts of the world represents a potential health hazard for young children, for their needs are great at this age, and they are highly sensitive to outside aggressions as well. We must therefore assess how breast-feeding is done, as well as the amounts and quality of breast-milk, so as to favour high quality breast-feeding.

The first step in these surveys is to define how breast-feeding is done. It is recommended to proceed by a cross-sectional survey of lactating and non-lactating mothers with children under 2 or 3 years old. The survey will tell us :

— the incidence and prevalence of breast-feeding ;
— the frequency of feedings ;
— the introduction of complemental foods, the types of food and the methods used to give milk complements ;
— the weaning foods used.

---

(1) Debry, G. Methodologie des enquêtes alimentaires. In : nutrition, métabolisme et diététique. Tchobroutsky, G. and Guy-Grand, B. Edition Flammarion. 1979. pp. 281-286.

(2) Block, GA review of validations of dietary assessment methods. Am. J. Epidemiology. 1982. 115. pp. 192-505.

Van Staveren, W.A. and Burema, J. Validity of dietary survey methods : a critical approach. In : evaluation of nutrition education in third world communities. Edit. Beat. Schürch. Hans Huber, publishers. 1982. pp. 69-81.

Paul, A.A. Food composition and the use of food composition tables. In : evaluation of nutrition education in third world communities. Edit. Beat. Schürch ; Hans Huber, publishers. 1982. pp. 82-100.

The objective of the second step is to determine the amount of milk secreted by the mother and taken by the child, and to define the nutritive qualities of this milk. The amount of milk secreted by the mother is determined by weighing, to measure the amount of milk taken by the child at each feeding over a 24-hour period. This method requires a strict but feasible method, costing nothing, requiring no heavy technology and involving no aggression to the "mother-child" couple. Other methods do exist (1). The measurement of the different nutrients contained in breast-milk does require more sophisticated technology, on the other hand (2).

1.2. Activity and energy expenditure

The nutritional status of an individual is conditioned not only by his/her dietary intake, but also by his/her physical activity, causing expenditure of energy. The relationship between physical activity and energy requirements determines the individual's nutritional balance, in the last analysis, and the need to increase or decrease his/her daily food intake.

It is not easy to evaluate the amount of energy usually spent ; this requires a strict methodology and appropriate technology. A daily record of activities must be kept, in order to evaluate the amount of energy spent. The different daily activities may be grouped and their respective duration carefully specified ; for example, 438 minutes for the time spent in bed, 310 minutes sitting down, 122 minutes for walking, etc. The energy spent may then be evaluated for each activity, by indirect calorimetry (3). Each measurement may last 10 to 15 minutes, but it must be done for each major activity. Published tables may also be consulted, especially for relatively infrequent activities, so as to avoid great errors.

It is clear that such evaluation of energy expenditures requires the collaboration of specialized teams accustomed to such surveys. In everyday practice, we may obtain a general idea by setting up a daily record of activities. This approach provides much valuable information which will shed light on the nutritional situation of the families in the community, and may lead to simple actions aimed at improving this situation.

Physical activity is generally reduced in the industrialized countries, but we may expect it to be much greater in the developing countries : in Central Africa, for instance (4), the women do most of the heavy farm work, while the men care for the banana plantation and - increasingly rarely - clear land for new fields. Rural women

---

(1) Coward, W.A., Whitehead, R.G., Sawyer, M.B., Prentice, A.M. and Evans, J. New method for measuring milk intakes in breast-fed babies. Lancet. 1979. II. pp. 13-14.

(2) W.H.O. Report of a cross-sectional study of the quantity and the quality of breast-milk. OMS Geneva (in press).

(3) Durnin, J.V.G.A., Brockway, J.W., Determination of the total daily energy expenditure in man by indirect calorimetry assessment of the accuracy of a modern technique. Br. J. Nutr. 1959. 13. pp. 41-53.

(4) Vis, H.L., Pourbaix, Ph., Thilly, C. and Van der Borght, H., Analyse de la situation nutritionnelle de sociétés traditionnelles de la région du lac Kivu : les Shi et les Havu. Enquête de consommation alimentaire. Ann. Soc. Belge Med. Trop. 49. pp. 353-419.

are often pregnant, then lactate, and therefore have greater energy requirements. They may of course adjust to this situation by reducing their activities, thanks to protective cultural customs, in particular, but often they are unable to reduce their physical activity.

Since food consumption cannot increase, the pregnant woman - for example - is obliged to draw on her reserves in order to satisfy her greater need for energy. Since she does not gain enough weight during pregnancy, the mother may give birth to a baby weighing less than normal. We should also note that heavy physical work may in itself constitutes a major risk factor for pregnant women, causing low birth weight in babies (1). Given the extent of the problem and the present impossibility of a simple, accurate evaluation of energy expenditure linked with different activities, the simple description of these activities and of their respective duration represents one simple but important step in improving our evaluation of the nutritional situation.

Once the surveys are ended, the information on the daily records must be expressed with respect to sex, age, place and time, for daily activities may vary with these factors. Local variations may also be considerable within a given region.

Example (2)

In Zaire, in the Kivu region, daytime activities (from 6 A.M. to 6 P.M.) were recorded for some lactating women, urban (43) and rural (41) : two observers followed each woman throughout the day, taking careful note, minute by minute, of their activities. These precautions were taken so as to modify the women's usual activities as little as possible.

Table 24 shows the activities of lactating women in these two areas. The time spent proportionally at work includes not only the field work itself, but also the time required to go there, while the rest periods in the fields are counted as "rest and light activities".

Table 24
Time (in %) spent at different activities by lactating urban and rural women in May-June-July 1982.
Observation period : 6 A.M. to 6 P.M.

	Urban area	Rural area
Rest and light activities	55.6	19.9
Activities at home and in the village	39.7	42.8
Work in the fields	4.7	37.3

(1) Tafar, J.N., Naeye, R.L., Gobezie, A. Effect of maternal undernutrition and heavy physical work during pregnancy on birth weight. Br. J. Obstet. Gynaecol. 1980. 87. pp. 222-228.

(2) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

Rest and light activities inclued pleasurable walks, social activities (visits to friends, to the health centre, etc.), while activities at home mostly include housework, fetching firewood, carrying water and visits to the local market. Field work mainly involves ploughing, sowing, planting, general care and transportation of the crops.

Although energy expenditures could not be calculated, we may reasonably consider that these expenditures were greater for the rural women, owing to their work in the fields. For comparison's sake : Bleiberg et al., in Upper-Volta (1), show that howing is one of the most energy-consuming activities for women (18.1 Kj/minute), while cleaning clothing and walking represent respectively expenditures of 13.5 Kj/minute and 12.6 Kj/minute. Within a given region, these activities may vary in the course of the year, and from year to year. Seasonal variations have in fact been clearly demonstrated, and should be specified, since the woman's activities are generally heaviest at the time of year when energy and protein intakes are lowest (2).

Example (3)

The application of the method described in the previous example enabled us to discover that in the Kivu region of Zaire the proportion of time spent at field work is greater during the protein shortage period (September-October - November) than during the previous three months. This proportion is respectively 16.4 % in urban areas and 49.3 % in rural areas, whereas during the previous three months it is 4.7 % and 37.3 %, in the same areas. We may then calculate the amounts of calories and of the differents nutrients consumed by small children.

The World Health Organization in Geneva in collaboration with the International Children's Centre, has recently organized a joint study on breast-feeding. It contains all necessary information on the organization of such surveys (3, 4). Findings on breast-feeding will also be expressed in terms of age, sex, place and time. Indeed, the types of feeding, as well as the prevalence of breast-feeding, exclusive or mixed, the frequency of feedings, the amounts and quality of milk vary with the age of the breast-fed child.

Example (5)

In the urban area of Bukavu (Zaire), we have performed tests for milk secretion, sa os to determine the amount of milk secreted by the mother and taken by the child

---

(1) Bleiberg, F.M., Brun, T.A., Goihman, S. and Gouba, E. Duration of activities and energy expenditure of female farmers in dry and rainy seasons in Upper-Volta. Br. J. Nutr. 1980. 43. pp. 71-82.

(2) Vis et al., Op. cit.
Paul, A.A., Muller, E.M., Whitehead, R.G. The quantitative effects of maternal dietary intake on pregnancy and lactation in rural Gambian women. Trans. R. Soc. Med. Hyg. 1979. 73. pp. 686-692.

(3) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

(4) WHO. Contemporary patterns of breast-feeding. Geneva. 1981.

(5) Hennart, Ph., Rushababisha, M. and Vis, H.L. Breast-feeding and post-partum amenorrhoea in Central Africa. 3. Quantity of milk in urban area in Central Africa. J. Trop. Pediat., 1983, 29. pp. 185-189.

over a 24-hour period. Table 25 shows these quantities according to the age of the breast-fed child. We may see that throughout the first year of post-partum, mothers are able to furnish their child with large quantities of milk, on the average. These quantities then decrease gradually.

Table 25
Quantities of milk secreted by the mother and taken by the child during a 24-hour period according to the age of the breast-fed child
Tests done in an urban area
Average ± standard deviation

Breast-feeding period	Number	Amount of milk (g/24 h)
1 month ± 1 week	6	737 ± 270
3 months ± 2 weeks	20	786 ± 221
6 months ± 2 weeks	7	680 ± 221
9 months ± 4 weeks	16	656 ± 135
12 months ± 4 weeks	16	687 ± 190
15 months ± 4 weeks	12	369 ± 189
18 months ± 4 weeks	3	325 ± 105
24 months ± 8 weeks	1	300

Major differences also are seen between different environments, not only between different regions but also between urban and rural areas within one region. In addition, socio-economic factors may considerably influence the findings within each of these areas.

Example (1)

Regular observation of the children registered at the infant consultations in the different sub-regions of Kivu, Bukavu (urban area), Kabare (rural area) and Idjwi (rural area) has shown us that the duration of breast-feeding is shorter in the urban area and longest in the rural area of Idjwi (figure 10). These findings were confirmed by cross-sectional surveys.

Time should also be taken into account, since the family's nutritional situation, eating habits and "mother-child" relations are some of the factors which may change as the seasons or the years go by.

Example (2)

During the milk secretion tests performed in Kivu (Zaire), the women naturally fed their child upon demand, as they do traditionally in this rural region. However,

(1) Hennart, Ph., Rushababisha, M. Unpublished findings.

(2) Hennart, Ph. and Vis, H.L. Breast-feeding and post-partum amenorrhoea in Central Africa. 1. Milk production in rural areas. J. Trop. Pediat., 1980, 26. pp. 177-183.

DURATION OF BREAST-FEEDING, CHILDREN FOLLOWED UP AT INFANT NUTRITION CENTRES

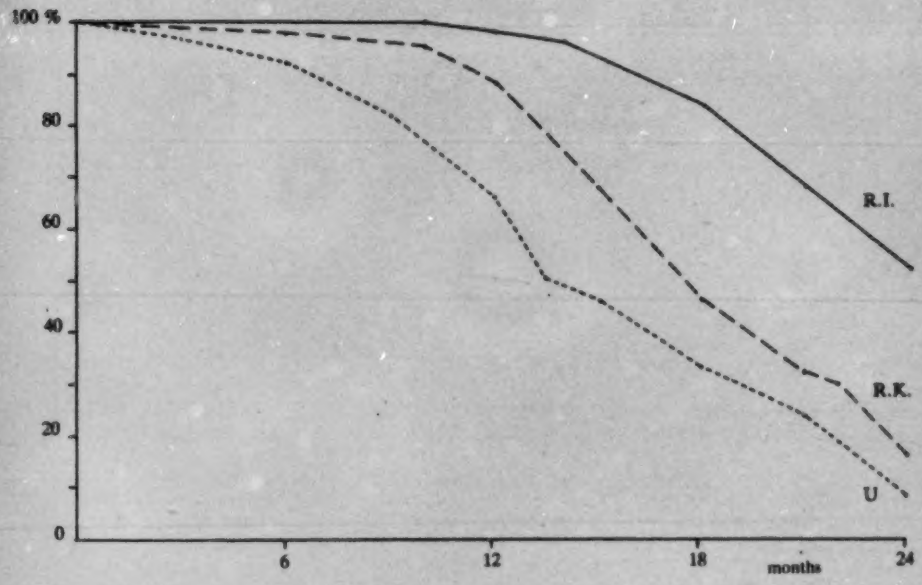

Figure 10 :
Percentage of breast-fed children according to child's age, in an urban area(U) and in the rural areas of Kabare (K) and Idjwi (I)

we observed great differences in the mothers'behaviour at different seasons. During the good season (June-July), when the harvest is satisfactory and the mothers well nourished, the feedings are more frequent per 24 hours than during the protein shortage period (October-November) (table 26). During the protein shortage period, women have a greater energy expenditure but are less well nourished. This observation, made in a care centre, was subsequently confirmed in the villages.

We may improve our understanding of the nutritional situation of families, and of "mother-child" couples in particular, by simply describing these findings, comparing them with those seen in other regions (in the same or other countries) and if possible. with findings made in the same region with an identical method at an earlier date.

Table 26
Frequency of feedings per 24 hours at different seasons in "mother-child" couples living in the rural area of Idjwi

	Time of year	
	June-July	October-November
Frequency of feedings per 24 h	16 ± 1 (148)	10 ± 2 (166)

2. Familial factors

2.1. Intrauterine growth and birth

We have already seen the importance of the period of foetal life for the child's future, and how it depends on the mother's health and nutritional status.

In the industrialized countries, the average at-term baby weighs 3.300 kg. In the developing countries, the average birth weight for a normal gestation period with the lowest risk of sickness and death is between 2.5 kg and 4 kg (WHO). Weight may be influenced by various factors (1).

— the mother's weight and height, taken separately or together ;
— birth rank and mother's age ;
— the mother's nutritional status ;
— weight gained during pregnancy.

This weight also depends on the mother's health : infections (rubella), serious diseases (heart disease) or intoxications (smoking) may also disturb proper growth.

In the industrialized countries, pregnant women have gained average of 4 kg at 20 weeks and 12.5 kg at term. The average range is between 9 and 12-13 kg. When they leave the hospital after delivery, their average weight is about 4.4 kg higher than before their pregnancy. They lose this excess weight gradually, particularly if they breast-feed.

In famine situations, if the dietary restriction occurs during the last two trimesters of pregnancy, the birth weight, placental weight and to a lesser extent the height at birth are low.

---

(1) Waterlow, J.C. Observations on the assessment of protein-energy malnutrition whith special reference to stunting. Courrier. Janv. 1978, 28. pp. 455-459.

Many studies done in the developing countries show that moderate maternal malnutrition greatly influences foetal growth and birth weight (1). In these regions, the prevalence of "low birth weight" is much greater than in industrialized areas, and a birth weight of 2.5 kg or less has been found to be generally linked to a high risk of death for the child. In addition, maternal malnutrition may also influence the child's subsequent growth : a child born at term with a low birth weight will have less satisfactory height and weight growth than one born prematurely with an equally low birth weight.

2.2. From birth to adulthood

During this period of life, the influence of the family gradually declines.

The child's first food is breast milk. The advantages of breast-feeding are numerous, varied and increasingly well known, and an exhaustive review of the literature on this subject has recently been published (2). The child's health does not depend upon the sole fact of breast-feeding : it is also important that the mother be in good health and have a satisfactory nutritional status so that she may secrete enough milk. In addition, the mother's behaviour, the duration of lactation, the more or less early introduction of complemental foods are other factors which contribute to the child's nutritional status.

The introduction of complemental foods is an important phase in the child's food situation, since it corresponds to the child's first separation from the mother - with respect to food, in any case - and also to closer contact with the physical surroundings. These complemental foods depend upon the family's diet and dietary customs.

The place of these complemental foods in diet gradually increases until weaning, after which the child will receive a share of the family dish. Of course, the distribution of the food within the family depends on the composition of the family : the larger the family, the greater is the risk that the youngest member will receive a very small share. The consequences for the small child's growth and health are particularly serious, since this is a time of life when growth is still rapid, and the child cannot make up for this insufficient diet by personal activity outside of the family.

Many studies show the harmful effect of a large family on dietary intake (3), morbidity (4) and mortality (5) of mothers and children. Men are much better protected. The influence of the family is not limited to its size ; its structure, and especially the interval between births, is also important. As a fact, studies show the existence of

---

(1) Kusum, P. Shah. Maternal nutrition in deprived populations. Assignment children. 1981, 55/56. pp. 41-72.

(2) Breast-feeding, fertility and family planning. Population Reports, series J., 1981, 24.

(3) Vis, H.L. et al., Op. cit.

(4) Wray, J.D. and Aguirre, A. Protein-calorie malnutrition in Candelaria, Colombie. I. Prevalence ; social and demographic factors. J. Trop. Pediat. 1969, 15. pp. 76-98.

(5) Wyon, J.B. and Gordon, J.E. A long term prospective-type field study of population dynamics in the Punjab, India. Research in Family Planning, Clyde V. Kiser. Ed. Princeton Univ. Press. 1962. pp. 17-32.

a relationship between the interval between births and morbidity (1) and mortality (2, 3). The mortality rates are higher when the interval between the birth of the child under study and that of the nearest older or younger child is smaller. The mother's nutritional status, her sexual behaviour, the duration and type of breast-feeding are factors which influence the relationship between mortality and the optimal interval between births. Like family size, child-spacing also influences the mother's nutritional status.

Very often, in the developing countries, the duration of breast-feeding is linked with the period of post partum amenorrhoea, which is approximately the period during which the woman is unfertile.

Example (4)

We have seen that the duration of breast-feeding is longer in rural Idjwi than in the urban area of Bukavu. Figure 11 shows that post-partum amenorrhoea lasts a long time, more so in rural areas than in urban areas. In Idjwi, one year after delivery only 19 % of mothers are menstruating and 2 years thereafter 20 % of mothers are still not menstruating. In the urban area, 1 year after delivery 50 % of mothers are menstruating and practically all are after 2 years.

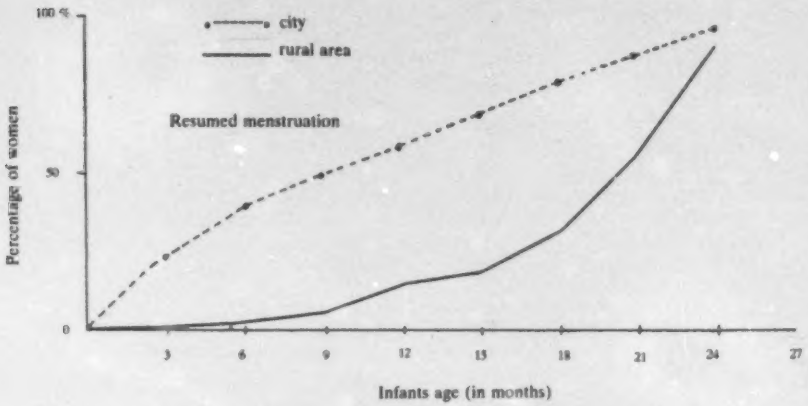

Figure 11 :
Prevalence of women menstruating since childbirth according to the post-partum duration in the urban area of Bukavu and the rural area of Idjwi

(1) Gordon, J.E., Wyon, J.B. and Ascoli, W. The second year death rate in less developed countries. Am. J. Sci. 1967 ; 254. pp. 357-380.

(2) Yerushalmy, J. On the interval between successive births and its effect on survival of infant. I. An indirect method of study. Hum. Biol. 1945, 17. pp. 65-106.

(3) Gray, R.H. Birth intervals, post-partum sexual abstinence and child health. In : Child-spacing in tropical Africa : Page, H.J. and Lesthaeghe, R. Academic Press. 1981. pp. 93-109.

(4) Vis, H.L. et al. Op. cit.

Eating habits, be they good or bad, affect people's nutritional status. They are related to family traditions and are sometimes founded physiologically. Farm families have eaten curdled milk, for example, long before the problem of lactose intolerance was discovered in these groups : curdled milk is much easier for them to digest than fresh milk. We should therefore be extremely cautious about modifying an eating habit or imposing a different one. People's food consumption is also influenced by their psycho-social behaviour. Paediatricians are well aware of the role played by food in the mother-child relationship. Refusal of food or excessive eating are often signs of emotional difficulties in the mother-child relationship.

All of these factors, consumption, health and family size, eating habits and psycho-social behaviour, are influenced in turn by the family's standard of living : a family with a higher standard of living is often better nourished.

Example (1)

We examined over 700 lactating women in Bukavu, Zaire, and collected some data on them. This enabled us to compare their nutritional status on the basis of the various criteria generally used to define people's standard of living.

Table 27
Comparison of anthropometric and biological data for lactating urban women with or without certain criteria

Criterion absent or present	URBAN AREA			
	W/H[2]	Army Circum.	Thigh. Circum.	Albumin
Home of durable building materials	N.S.	N.S.	***	N.S.
Facilities in home	N.S.	*	***	N.S.
Fields	N.S.	N.S.	N.S.	N.S.
Animals	N.S.	N.S.	*	N.S.
Shop	N.S.	N.S.	N.S.	**
Elementary schooling (started) Man	*	N.S.	**	N.S.
Secondary schooling (started) Man	N.S.	N.S.	**	N.S.
Elementary schooling (started) Woman	N.S.	N.S.	***	N.S.
Secondary schooling (started) Woman	N.S.	N.S.	**	N.S.
Wage earner (Man)	N.S.	N.S.	*	*
Wage earner (Woman)	**	N.S.	N.S.	N.S.

NB : the test results (analysis of covariance) are adjusted for the age of the breast-fed child. The differences noted all show higher figures when the criterion is present. Levels of significance : N.S. = Not Significant ; * P = 0.05 or under ; ** P = 0.01 or under ; *** P = 0.001 or under.

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

A higher standard of living may be seen to correspond to a more satisfactory nutritional status. When statistically significant differences are seen, the figures are always higher when the criterion for a higher standard of living is present. Within a given region, then, children's birth rate rises with their mother's standard of living. Weight and height growth of children within a region also varies with their parent's standard of living. This influence is not always positive, however. Obesity in well-to-do adults and the decreased frequency and duration of breast-feeding are examples of potentially harmful circumstances for individual and collective health.

3. Environmental factors

Environmental factors are extremely important, and they influence people's nutritional status in a variety of ways, either directly or indirectly, through the family for instance. They may affect the person's nutritional status by modifying his/her food consumption, physiological needs or expenditure of energy.

3.1. Factors acting directly

The most important ones are certainly infections and infestation with parasites. These are so extensive that in actual practice it is impossible to tell which, of infection and/or protein malnutrition, is finally responsible for the clinical picture shown by the child and, in extreme cases, for his/her death. Indeed, infections affect the patient's nutritional status and vice-versa. Malnutrition disturbs the defense mechanisms which produce immunity. Infections may interfere with the person's diet and nutritional status at various levels :

— decrease in appetite ;
— loss of food by diarrhoea or vomiting ;
— decreased absorption by the intestinal mucosa ;
— loss of serum proteins by the digestive tube ;
— deterioration of hormonal regulation mechanisms ;

Infections therefore greatly influence the main indicators of nutritional status :

— weight loss is frequent during bouts of infection and is particularly severe in case of diarrhoea ;
— serum albumin decreases during bouts of infection such as measles (1) and diarrhoea (2) or during infestation with parasites such as ancylostomiasis (3).

In addition, the clinical picture presented by the child may be affected by the influence of infections on hormone secretion, and more specifically upon the secretion of cortisol. The interaction between infection and diet is so great that Whitehead is

---

(1) Poskitt, E.M.E. Effect of measles on plasma-albumin levels in Ugandan village children. Lancet. 1971, II. pp. 68-70.

(2) Lunn, P.G. Whitehead, R.C. and Coward, W.A. Two pathways to kwashiorkor. Trans. Roy. Soc. Trop. Med. Hyg. 1979, 73. pp. 438-444.

(3) Blackman, V., Marsden, P.D., Banwell, J., Hall Craggs,M. Albumin metabolism in hookworm anemia. Trans. Roy. Soc. Trop. Med. Hyg. 1965, 59. pp. 472-482.

probably right in asserting (1) that malnutrition is not only increased by infection, but its clinical form may be changed, and even be unexpected for a given food intake. Digestive loss of serum albumin and high concentrations of cortisol may lead to all moderate forms of protein-energy malnutrition.

Malnutrition may also influence infection, either by modifying the individual's sensitivity to infection or by altering the course of the latter once it has affected the individual. Malnutrition increases sensitivity to infection by deteriorating the immunitary defense mechanisms (especially cellular ones). The final effect of this synergic effect of malnutrition and infectious and parasitic diseases is an extremely high death rate for children, especially those under 3 years old (2).

This synergy may also influence the child's growth : it is partially responsile for the levelling off of the weight growth curve observed in young children in the developing countries. This occurs at different ages in different regions, but always at a period which coincides with the introduction of complemental foods in a previously exclusively breast-fed child. This levelling off of the growth curve thus represents one of the first consequences of the environmental influence on the child's nutritional status.

These findings lead us to the following remarks :

— the death rate and all other serious consequences for individuals should be considered to involve the synergy of these two basic factors ;
— the description of the individual's nutritional status should be accompanied by the description of any infectious state and of any possible infestation with parasites ;
— surveillance of growth should take into account the impact of repeated infections and parasitoses upon children ;
— an epidemiological approach to nutritional problems should be accompanied by an epidemiological approach to infections and parasitoses ;
— vaccinations and early treatment of common infections are a most important means of improving the nutritional status of a population group ;
— individual treatment should be completed by measures for the improvement of the environmental hygiene and for education on this subject.

Our approach to these problems and the solutions proposed should always take this synergy between malnutrition and infection into account.

3.2. Indirectly acting factors

These are numerous and equally important, but their action is often less spectacular. The climate, the food resources (animal husbandry, farming), the overall socio-economic level of the region, the possibility of money income and population concentration are some of the important factors influencing the nutritional status of the population of a region.

---

(1) Whitehead, R.G. and Lunn, P.G. Endocrines in protein-energy malnutrition. Trop. Nutr. Soc. 1979, 38, pp. 69-76.

(2) Cantrelle, P. and Leridon, M. Breast-feeding, mortality in childhood and fertility in urinal zinc of Senegal. **Populations** Studies. 1971. **25**, 3. pp. 505-533.

Rapid, serious variations in these factors may cause imbalances in the nutritional status of those population groups involved. Natural catastrophes, wars, crop or cattle diseases, for example, may cause famines. The nutritional problems are easily identified in such cases, and the situation will return to normal more or less rapidly once the causal factors have disappeared. The epidemiology of disasters teaches us that major problems linked with the acute crisis situation may arise long after the acute occurrence itself. Crop destruction, lack of hygiene, psychophysiological disturbances within the population are some factors which may influence the nutritional status of the population in the more or less long run. Quite often, in these cases, international food aid is offered and solutions are proposed, although they are not necessarily adequate nor appropriate to the needs of the population.

Other situations, unfortunately the most frequent ones, are much less spectacular but equally disastrous for the nutritional status of the population. These include a decreased soil productivity due to gradual soil erosion or more or less severe drought, an increased population concentration due to an increase in population and/or migration, a very low standard of living for part or all of the population of a region, continuous deforestation, geographic isolation, very rapid urban development and behaviour modifications. This means that only an ongoing evaluation of the nutritional status of population groups may indicate the possible influence of these factors on their health status. Even if the actions required do not depend entirely upon the health officials, only such ongoing evaluation will identify high-risk situations for the health of families. Health workers therefore have a fundamental role to play it is they who may perceive these influences on the health status of the community and who should be capable of specifying the main demographic and socio-economic characteristics of these modifications.

To do so, they may use a number of indicators :

— demographic : breakdown of the population by sex, age and ethnic group... ; family status ; birth and death rates, broken down by age or age group, etc. (figure 12) ;
— socio-economic : father and mother's professions, money income, educational level, housing, etc.

Example

Figure 12 shows the average number of live-born children and of live-born and surviving children per mother for the women over 15 years old in Idjwi and Kabare. It also shows the percentage of survivors in each of these two regions. In Kabare, the average woman has had 9 childrens at the end of her fertile life, whereas in Idjwi she has had to 8. However, the women of Kabare and Idjwi have the same number of live children at the end of this period : 4 to 5. Indeed, the percentage of deceased children for those born live in a family is constantly higher in Kabare than in Idjwi. The region of Kabare differs from Idjwi, then, by a higher death rate in children along with a greater fertility in mothers.

Some classifications have been suggested for the industrialized countries, and we may refer to Graffar's classification (1) for example. It takes into account the parents'

(1) Graffar, M. Une méthode de classification sociale d'échantillons de population. In : Courrier 6/8. 455, 1956 (Paris, CIE).

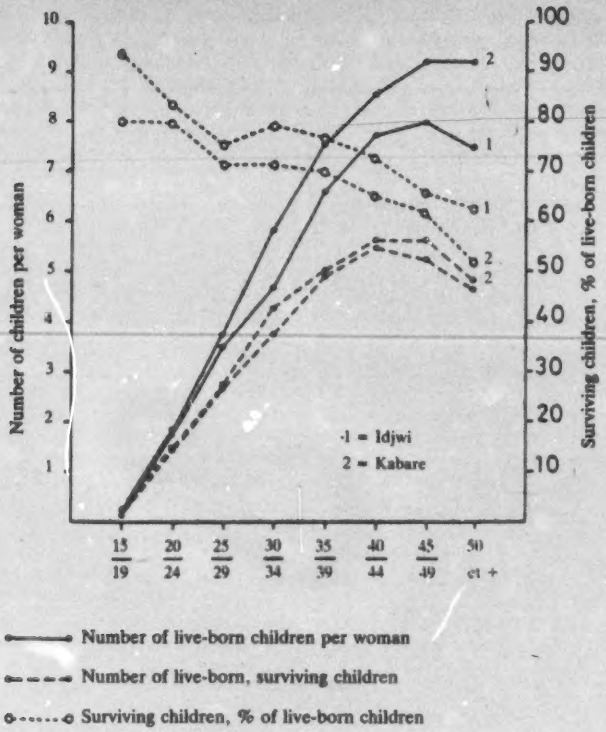

Figure 12
Comparison of average number of live-born children, live-born, surviving children and % of surviving children for live-born children per mother in Idjwi and Kabare. The average figures are expressed per 5-year age group.

profession and level of education, the source of family income, the quality of housing and of the neighbourhood.

For the developing countries, it is preferable to determine one or two simple indicators, rather than to attempt to establish an overall index of standard of living. Studies show that in these countries family consumption improves when the money income increases and, simultaneously, that the risk of death for children - for example - increases when the family's standard of living drops.

There is another series of factors which cannot be identified by health workers. Soil productivity, the quality and number of animal farms will be evaluated by agronomists and veterinarians in charge of the region, for instance. Similar approaches, by officials working in other fields (economics, education, etc.) should provide a thorough understanding of the regional problems ; correlations should be established between the different findings.

III. THE ANALYTIC APPROACH ANALYSIS OF THE FACTORS DETERMINING THE HEALTH AND NUTRITIONAL STATUS OF POPULATION GROUPS

The first step in our approach consisted in the description of the collective nutritional status at a community level, and of the different factors which may influence it. If we are to go on to guiding health decisions and actions, we must thoroughly analyse the health hazards which may cause certain variations in the nutritional status of community members, and if possible, bring out the optimal nutritional status for these members, given the genetic factors and the influence of the environment. An analysis of the relative seriousness of these different influences and of their effects on the nutritional and health status of the population will then enable us to define the objectives and the top priority actions for a given community.

1. Analysis of the relative seriousness of the different forms of protein-energy malnutrition

In chapter I, we have shown that the anthropometric indicators provide specific information on the energy component of protein-energy malnutrition, whereas clinical and biological data are mostly used to evaluate the extent of the protein component of malnutrition. We must now define those anthropometric, clinical and biochemical indicators which are clearly linked with the prevalence of a symptomatic state and, above all, what risk of death is associated with different figures for these indicators.

The data found in **hospitalized children** furnish precise information on the indicators of protein-energy malnutrition linked with high risks of death.

Gomez et al. (1) have shown that the mortality of hospitalized children is higher when the weight for age is below 60 % of the theoretical median weight (50th percentile). They observed 733 children hospitalized between 1949 and 1952 in Mexico City, with the following characteristics :

— average age : 31 ± 17 months ;
— weight 60 % of the theoretical median weight or less : 81.9 % of the children ;
— oedema present in 71 % of cases ;
— diarrhoea in 70 % and signs of dehydration in 56 %.

Skin disorders were also very varied and frequent. Overall mortality was 31 %, but it was highest during the first two days (44 %), then dropped to 20 %.

---

(1) Gomez, F. ; Ramos Galvan, R. ; Frenk, S. ; Cravioto Munoz, I. ; Chavez, R. and Vasquez, I. Mortality in second and third degree malnutrition. J. Trop. Ped., 1956, 2 : pp. 77-83.

These authors base each of their analyses on the entire group of children, and demonstrate that those children whose weight for age is, at most, 60 % of the median weight (3rd degree malnutrition) have a higher death rate than those whose weight for age is between 61 and 75 % of the median weight for age. Neither oedema nor skin disorders were indicative of high risk of death. In the same table, the authors show that weight for age is only a discriminative factor for death during the first 2 days : this is no longer the case for later deaths. In addition, the probable causes of death are shown to be linked with dehydration and electrolytic disorders in 69 of the 105 children who died during the first 48 hours. For all of these children, Gomez emphasizes the importance of certain clinical signs which go along with a high death rate : dehydration, diarrhoea without dehydration and bronchopneumonia. These findings are important, since they confirm the value of a classification still in commun use, known as the "Gomez classification".

Low weight for age is both an indicator of nutritional status and of dehydration : a classification of nutritional status can therefore not be based on this criterion only, since the figures and their variations are not unequivocal.

Many authors have analysed the data of **hospitalized children** and attempted to discover the major factors linked with a high death rate. A certain number of important points may be deduced from these results :

— weight for age and weight for height are very often linked with high risks of death, but in these cases dehydration is frequent and electrolytic disorders are also mentioned as a major risk factor. The disorders observed in the metabolism of water and of electrolytes depend on factors other than protein-energy deficiency, however. These include the electrolyte content of the deficient diet ;

— decreases in the amount of proteins by the liver, such as albumin, transferrin and prealbumin, are constantly linked with a greater risk of death. On the other hand, the other clinical signs classically described as specific to protein malnutrition are not found to be linked with a higher risk of death. Œedemas, for instance, are never mentioned as as discriminating factor for mortality in children hospitalized for protein-energy manultrition :

— when proteins are measured, the other factors such as weight for age and height for age are no longer found to be discriminant.

The symptoms of protein-energy malnutrition are very varied, and actually all intermediate forms may be encountered. **It would therefore be vain and dangerous to rely on a single indicator for the identification and detection of severe or moderate cases of protein-energy malnutrition. A series of indicators should be taken into consideration.**

Anthropometric data such as weight for age, height for age and weight for height should definitely be used, but in a more dynamic fashion than is generally the case. Indeed, loss of weight and dehydration seem to be much more important than the weight itself. It would therefore be dangerous to base our evaluation of an individual's nutritional status on this indicator alone, since it may be encountered in a great variety of pathological states (energy malnutrition or gastroenteritis, for example). In addition, anthropometric data do not enable us to evaluate the seriousness of protein

deficiency. The proteins produced by the liver, and serum albumin in particular, seem to be particularly useful indicators of the protein component of malnutrition.

Unfortunately, the clinical signs of protein malnutrition are not as valuable. Disorders of the skin or the hair are not in fact specific to protein malnutrition, and may be seen in zinc deficiency, in particular. It has also been shown that in protein-energy malnutrition, low serum zinc concentrations are linked with nutritional oedema, retarded weight and height growth and skin disorders, but there is no correlation with serum albumin, which is low in malnutrition while it is normal in isolated zinc deficiency. Oedema is difficult to quantify and is mostly seen in severe forms of protein-energy malnutrition ; it is not exclusively linked with a diet poor in proteins, and above all does not represent a high risk factor for death in children with protein-energy malnutrition.

To summarize the investigations done in hospitals, then, we find that anthropometric data furnish information on the child's nutritional status, but above all, they should be recorded in a dynamic manner, that is, followed longitudinally and compared to earlier data. Serum proteins, and especially albumin, seems to be an indispensable element in indentifying protein malnutrition and evaluating the vital prognosis of the hospitalized child.

Some prospective studies of **non-hospitalized children** consider the longer term risk of death for these children, depending on their nutritional status.

One of the first prospective studies is based on the risk of death and nutritional status (Sommer and Lowenstein). Over 8,000 children living in rural Bengladesh and aged 1 to 9 years were followed up for 18 months following the evaluation of their nutritional status using arm circumference for height. The reference curve used is a local curve. The risk of death for children below the 10th percentile and between the 10th greater and the 50th percentile is respectively 3.4 and 1.5 times greater than for those located above the 50th percentile. The gradient is present at all ages but is higher in children aged 1 to 4 years (1 to 4.5) or in those whose height is between 65 and 89 cm (1 to 4.1). The differences are greatest during the first months after the examination (1 to 19.8), while this indicator becomes much less discriminative for death during the **last three months** of the 18-months follow-up (risk varying from 1 to 2).

In another prospective study done in India, again in a rural area, Kielmann and McCord observed 2,208 children aged 1 to 36 months and used weight for age as an indicator of the children's nutritional status. They found that on the average, the children's death rate doubles with each 10 % decrease below 80 % of the Harvard median weight. Their results also show that the risk of death during the first 12 months after the evaluation of nutritional status is inversely proportionate to age (at the time of the first study). The risk is much greater during the first 6 months after the anthropometric examination than during the following 6 months. There is also a correlation between mortality and the seasons : there are more deaths at the time of year when the food reserves are exhausted, when mothers work intensively in the fields and neglect their children and when diarrhoea and dehydration are most frequent.

In rural Bengladesh, Chen et al. followed 2,019 children aged 13 to 23 months for a 24-month period. An evaluation was made of their nutritional status, using different

anthropometric indicators and essentially weight for age, weight for heigth, height for age, arm circumference for age and arm circumference for height. The results show that severely malnourished children, as judged by these indicators, have a higher risk of death during the observation period. The risk for children with severe malnutrition is higher during the second year of observation ; that is, when they are aged 3 to 4 years, than during the first year, when they are aged 2 to 3 years.

While all of the indicators used in this study differenciated children with a high risk from the others, weight for age and arm circumference for age seem to be the most discriminating. Weight for height and height for age are even more discriminating if used jointly, according to Waterlow's classification.

		Weight/Height	
		Under 80 %	Over 80 %
Height/age	Under 90 %	stunted, thin	stunted
	Over 90 %	thin	normal

Last, other indicators such as the mother's nutritional status (weight or height) or living conditions further improve the differentiation of children at greater risk of death.

These three prospective studies attempt to identify those children at high risk of death at more or less long term, using indicators of nutritional status. Their merit is that they provide an instrument for the measurement of nutritional status which may be used by local health workers, but some remarks are required so that any further field studies can be complete. It should be stressed that the indicators used do not identify protein malnutrition. These investigations, based solely upon the data collected at the time of the survey and then evaluated with no reference to the child's past history, prior nutritional status, weight and height at birth, anthropometric data such as weight for age and height for age cannot be analysed dynamically, taking into account, most importantly, the course of the child's life. The influence of the family must also be taken into account, and above all the influence of the mother on the child's health, at those times of life when that influence is greatest. Last, any infectious or parasitic diseases present in the child at the time of examination must be taken into account.

In practice, in the face of widespread protein-energy malnutrition within a region, we may discover which nutritional indicators are linked with a high risk of intra-hospital mortality by analysing the data collected in the hospitals ; this is useful since we have no access to universally valid results, in fact.

Example (1)

In Kivu, all hospitalized children have a complete record containing a great many data. A yearly reading of these records makes it easier to examine those points which seem important ; that is, to carefuly define the hospitalized population and to evaluate medical action. If, for instance, intra-hospital mortality is viewed in relation to some indicators measured upon entering the hospital, we find a risk gradient correlated with the anthropometric data and the serum albumin concentrations (table 28). The lower these indicators, the higher the death rate. In addition, the preschool-age period is the time of greatest risk for these people.

Table 28

Percentage of deceased children and some characteristics of their nutritional status when entering the hospital, with reference to the child's age
Levels of significance (X^2 test) : N.S. = Not Significant ;
** P = 0.01 or under ; *** P = 0.001 or under.

INTRA-HOSPITAL MORTALITY (in %) (1)

PATIENTS AGE (in years)	0 - 1	2 - 5	6 and +
Weight for age (2)			
> Percentile 5	7.4 (217) ***	9.2 (185) ***	7.4 (136) N.S.
< Percentile 5	18.2 (264)	20.4 (314)	10.2 (177)
Weight for height (2)			
> Percentile 5	7.8 (218) ***	11.4 (297) ***	8.4 (166) N.S.
< Percentile 5	17.6 (91)	25.4 (142)	13.6 (59)
Serum albumin (g/dl)			
2.30 and +	7.3 (302)	8.5 (164)	3.7 (218)
1.60 – 229	14.5 (83)***	13,7 (153)***	10,8 (93)***
1.59 and –	33.3 (36)	27.3 (143)	17.6 (68)

(1) Including children arriving at hospital just before death (1/3 of deaths).
(2) The reference curves are local ones established by De Mayer in 1959.
NB : The number of patients is in parentheses.

In a second phase, still in this hospital setting, we will attempt to analyse the possible correlations between these indicators so as to bring out those which are linked with a greater risk of death for hospitalized people.

---

(1) Hennart, Ph. Brasseur, D. Tshimpaka, K. and Vis, H.L. Unpublished findings.

Example (1)

In the hospitalized children described above, a two-by-two analysis of the data showed the following points (table 29) :

- the percentage of deaths is always higher when the serum albumin concentration is low, regardless of whether the child is marasmic (weight for age below percentile 5) or not ;
- in children with similar serum albumin concentrations, the death rate is higher when marasmus is present.

These two components of nutritional status (protein and energy components) combine their effects, and it is therefore important to identify both of them very precisely.

Figure 29
Percentage of deceased patients and serum alumin concentration when entering hospital, according to the child's weight for age.
Level of significance : *** P = 0.001 or under.

INTRA-HOSPITA MORTALITY [1]
(in %)

	WEIGHT FOR AGE > PERC. 5 [2]	WEIGHT FOR AGE < PERC. 5
Serum albumin (g/dl)		
< 1.59	21.1 (90)	27.4 (146)
1.60 - 2.29	10.3 (97)	15.2 (211)
> 2.30	2.8 (287)	8.7 (321)
	$X^2_{2dl} = 33.02^{***}$	$X^2_{2dl} = 27.87^{***}$

(1) Including children arriving at hospital just before death (1/3 of deaths)
(2) Local curves established by De Mayer (1969)
NB : The number of patients is in parentheses.

Last, once we have determined the most important indicators of nutritional status with respect to their correlation with a higher risk of death in hospital, the next step is to prove or disprove the relative importance of these indicators outside of any hospital structure. Prospective studies are particularly appropriate to this type of approach.

Example (2)

In a prospective study done in Kivu outside of any health structure, we followed 500 children regularly over close to 2 years. At the beginning, each child and his/her parents were carefully examined and many variables noted. The use of more complex

(1) Hennart. Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis. 323 p. 1983.

(2) Hennart. Ph. Brasseur, D. Tshimpaka, K. and Vis. H.L. Unpublished findings.

statistical methods (multi variate analysis and others) confirmed the hospital findings on the extreme importance of serum albumin. The lower the latter, the greater the risk of death run by the child, even outside of any hospital structure.

The fact that the results agree is a further argument for the identification of the severity of the different forms of protein-energy malnutrition observed in a region, in order to define the top priority problems in that region.

While these three approaches should first be used to define those nutritional statuses correlated with the greatest risks for individual health, they may also be used to identify the states more particularly linked with physiological or behavioural disturbances - for instance-which in turn may indirectly affect the nutritional and health status of members of the family.

It is no excessive generalization to say that the results and observations from Kivu (Zaire) show how important it is to carefully define the protein component in malnutrition for the entire population and especially in preschool children, since it is linked with high risk of death. If we wish to determine the nutritional status of the population with respect to proteins, and assess the highest risk groups and/or periods, we must evaluate the serum albumin concentrations of the entire population.

Example (1)

In the rural area of Kabare, in Kivu, where the nutritional situation is hardly satisfactory, we found that mothers secrete very little milk. Table 30 shows the amounts of milk secreted per 24 hours with reference to the nutritional status of these rural mothers. We find that the amounts of milk are lowest when the mothers have severe protein malnutrition and their serum albumin concentrations are very low.

Table 30

Amount of milk secreted by mothers over a 24-hour period and indicators of the protein component of protein-energy malnutrition in the mother.

Average ± standard déviation.

Levels of significance : N.S. = Non Significant ; *** P = 0.001 or under.

AMOUNT OF MILK SECRETED OVER 24 HOURS IN A RURAL AREA

	NO	YES	T Test
Abnormal hair	336 ± 162 (628)	327 ± 145 (61)	1.38 N.S.
Abnormal skin	355 ± 161 (712)	369 ± 153 (6)	0.24 N.S.
Oedema	353 ± 162 (706)	324 ± 170 (7)	0.47 N.S.
Serum albumin < 2.30 g/dl	357 ± 166 (634)	306 ± 108 (62)	3.48 ***

N.B. : The number of persons is in parentheses.

(1) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

2. Analysis of the importance of the different factors which may influence the nutritional status of population groups

If we wish to bring out any existing relationship between the different factors described above and the nutritional status of a population group or some part of it, we should compare the risks of protein-energy malnutrition when the factor involved is present or absent. The analytic epidemiology techniques will enable us to do studies which will determine whether such a relationship actually exists or not.

We must remember that a strict analysis is required in order to interpret epidemiological results, with an attempt to prove that the disease-factor relationship is not due to chance, nor linked with the action of other, concomitant factors, that it may be generalized and last, that there is really a causal relationship. We do no intend to explain these epidemiological techniques here (1) ; some simple examples will show the importance of observation in our everyday activities.

Example (2)

In the Kigali hospital in Rwanda (in an urban area) as well as in the Lwiro hospital in Zaire (in a rural area), the intra-hospital mortality of children under 2 years old is systematically higher when the child is no longer breast-fed than when he or she is still breast-fed (figure 13).

In Kigali, the mortality is 14.6 % in breast-fed children (N = 1,636) and 28.1 % in those weaned (N = 703). In Lwiro, the mortality is also lower in breast-fed children (11.5 % ; N = 61) than in those weaned (17.6 % ; N = 51). It should be noted that the breast-feeding period is very long in both of these regions, although its duration is tending to drop in the urban area.

We will illustrate this approach by only two factors described in chapter I ; that is, breast-feeding and family size.

2.1. Breast-feeding

In the non-industrialized countries, breast-feeding is described as one of the best preventive measures against protein-energy deficiency and death in small children. In addition, one of the advantages of breast-feeding is that it contributes to a special mother-child relationship, while weaning from the breast is often tied to psychological and emotional weaning as well. Given the different ways in which breast-feeding is practiced, as well as the variety of environmental factors, it is possible that this assertion is not necessarily true everywhere, and particularly in critical nutritional situations where the lactating mother herself has protein-energy malnutrition and many infants with severe protein-energy malnutrition may be seen.

---

(1) Rouquette, C., Schwartz, D. Méthodes en épidémiologie. Paris, Flammarion. 1970.
Jenicek, M. and Cleroux, R. Epidémiologie, principes, techniques, applications. Edisen et Malaine. 1982.

(2) Lepage, Ph., Munyakaz, C. and Hennart, Ph. Breast-feeding and hospital mortality in children in Rwanda. Lancet. 1981. II pp. 409-411.
Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

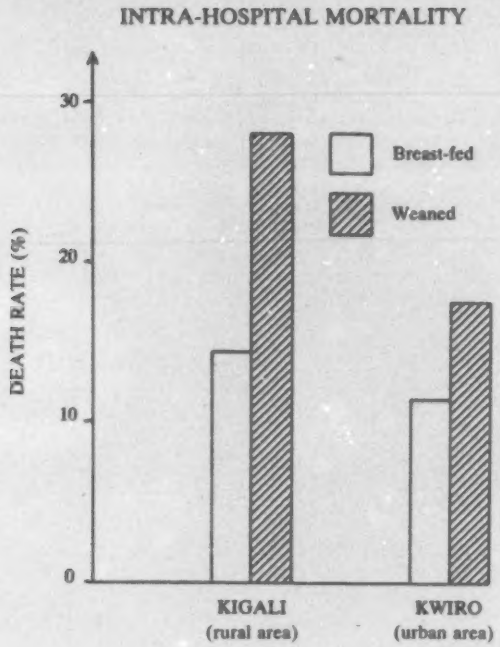

Figure 13
Type of diet and death rate in children under 2 years old hospitalized in Kigali (urban areas and in Lwiro (rural area)

Some extremely important information may be obtained by the analysis of hospitalization records, provided a number of data are collected systematically. We may, for example, compare the intra-hospital mortality of 2 year-olds who were or were not breast-fed just before admission to hospital.

We may also determine whether the protective effect of breast-feeding is the same regardless of the reason for hospitalization.

Example (1)

At the urban hospital in Kigali, Rwanda, the analysis of the data of children hospitalized in 1977 and 1978 shows that the death rate for children under 2 years old

(1) Lepage, Ph. Munyakaz, C. and Hennart, Ph. Breast-feeding and hospital mortality in children in Rwanda. Lancet. 1981. II pp. 409-411.

with measles, gastroenteritis and lung diseases is constantly higher in weaned children than in those still breast-fed (table 31).

Table 31
Type of diet and death rate for children admitted to the Kigali hospital

GROUP	NUMBER OF DEATHS/NUMBER OF CASES		
	MEASLES	GASTRO-ENTERITIS	LUNG DISEASE
Under 2 years old, breast-fed	159/728 (21.8 %)	39/595 (6.6 %)	42/313 (13.4 %)
Under 2 years old, weaned	103/307 (33.4 %)*	56/254 (22.0 %)*	39/142 (27.4 %)*
Age 2-15 years	89/514 (17.3 %)	16/161 (9.9 %)	13/153 (8.5 %)

* Significantly higher death rate in weaned children than in breast-fed children (P is under 0.001; X^2 test).

It is important to note that this difference in mortality between breast-fed and weaned children is statistically significant in children under one year old (P under 0.001) and also in those aged 12 to 24 months (P under 0.001). The same method may be used, for instance, to determine whether there are some periods where the risk is higher than others for weaned children under 2 years old.

Example (1)

In the previous example, the authors clearly demonstrated that the death rate for children under 6 months old is 20 % in weaned children whereas it is only 10 % for those who are breast-fed. This gradient remains practically the same for all age groups from 6 months to 24 months of age.

We may also compare the nutritional status of breast-fed children with that of weaned children outside of any crisis situation requiring hospitalization, through mother and child care consultations or surveys done outside of any hospital structure.

Example (2)

In Kivu, there are few children under 12 months old and living in the rural area of Idjwi who are not breast-fed, but the weight of such children rarely progresses in a satisfactory manner. On the other hand, the weight and height of breast-fed and weaned 12 to 24 month-olds are quite comparable. The same is not true of serum albumin

(1) Lepage et al., op. cit.

(2) Hennart, Ph. Allaitement maternel en situation nutritionnelle critique : adaptation et limites. Thesis, 323 p. 1983.

concentrations. Table 32 compares the serum albumin concentrations of breast-fed or weaned children under 2 years old, as measured during the clinical nutritional surveys done in the city and the villages of the region. These surveys took place in a city (Bukavu) and in the rural areas (of Idjwi and Kabare and the region of Lwiro). Regardless of the region, the average serum albumin concentrations are always higher when the children are breast-fed than when they are not.

Table 32

Comparison of serum albumin concentrations in children under 2 years old, breast-fed or weaned, in each of four regions.
Average ± standard deviation.

Serum albumin (g/dl)	Bukavu (Urban area)	Idjwi (Rural area)	Kabare (Rural area)	Lwiro (Rural area)
Children aged 0 to 1 year				
Breast-fed	3.47 ± 0.60 (95)*	3.38 ± 0.57 (257)	3.12 ± 0.46 (117)	3.42 ± 0.62 (126)
not breast-fed	3.21 ± 0.61 (56)	2,96 ± 0.71 (10)	2,78 ± 0.73 (6)	3.12 ± 0.56 (13)
T test (level of significance)	P under 0.001	P = 0.05 or under	N.S.	N.S.

* Number of children

All of these observations, and still others from Central Africa, clearly show that breast-feeding is still one of the decisive elements in satisfactory health and nutritional status in small children, whatever their age. This remains true even when the nutritional situation is critical for the entire community.

2.2. Family composition

Many studies show that a large family has a negative effect on the morbidity and mortality of the mother and the children. The influence of the family is not limited to its size : its structure, and more particularly the interval between births, also plays a role. There is a definite relationship between the interval between births and diseases and death. The death rates are higher when the interval between the birth of the child studied and the nearest older or younger sibling is shorter. A recent, critical analysis of published findings (1) concludes that despite the variety of investigation methods used, it is clear that a child born shortly before or after another has a lower chance of survival. The mother's nutritional status, her behaviour, the duration of breast-feeding and type of diet are all factors which play a role in the relationship between mortality and the optimal interval between births.

(1) Gray, R.H. Op. cit.

These different factors, family size, the child's birth rank and the intervals between births, may also affect the nutritional status of the different family members.

The family size, for example, may influence the energy intake of each individual within the family.

Example (1, 2)

Vis et al. have performed food consumption surveys in rural areas of Zaire and Rwanda, clearly showing that the energy intakes, expressed as a percentage of theoretical intake, are satisfactory provided the family has only one child under 15 years old. If the number of children increases, however, the energy intake decreases. This is explained by the fact that in an economy which is almost self-sufficient, the size of the fields tilled for food is limited by the physical effort which the adults working in them are able to furnish.

The nutritional status of each of the children may also depend on the number of children in the family and on their birth rank within the family.

Example (3)

In the nutritional surveys conducted outside of any health structure in the Kivu region, we compared the nutritional status of children under one with different birth ranks. Table 33 shows the serum albumin concentrations of children under one according to birth rank. In rural areas, the first child has a higher average serum albumin concentration than the next children. In the urban area the serum albumin concentrations are similar.

Last, several studies done in the non-industrialized countries, especially in rural areas, have clearly shown that children's nutritional status is less satisfactory when the birth interval between the child observed and the nearest older or younger sibling is shorter. This deterioration of nutritional status may lead to higher death rates.

Example (3)

A longitudinal study done in Kivu enabled us to do a 5-year follow-up on a group of children who had recovered from a bout of protein-energy malnutrition. The incidence of death was particularly high during the year following hospitalization, and mostly in children hospitalized before age 2 years. There is a high risk of death within the year after leaving the hospital for any child hospitalized for severe protein-energy malnutrition before the age of 2 years : this risk is somewhere between 40 and 50 %.

This study shows that none of the social, anthropometric or biological data characteristic of the children and collected during their hospitalization would identify this

---

(1) Vis, H.L. ; Poubaix, Ph. : Thilly, C. and Vander Borght H. Analyse de la situation nutritionnelle de Sociétés traditionnelles de la région du lac KIVU : les shi et les Havu. Enquête de consommation alimentaire. Ann. Soc. Belg. Med. Trop. 1969 ; 49 : 353-419.

(2) Vis, H.L., Van der Borght, H. and Yourassowsky, C. Une enquête de consommation alimentaire en République rwandaise. Institut National de Recherche Scientifique, Butare. Rép. rwandaise. Publication n° 10. 1972.

(3) CEMUBAC (Scientific and medical centre of the Free University of Brussels for its cooperation activities) annual reports. From 1973 to 1983 inclusive.

risk. The only finding linked with the child's health is one involving the mother : a short birth interval (under 21 months) is correlated with a high incidence of death for the child. Table 34 summarized the indicators used in this study.

Table 33

Comparison of serum albumin concentrations in children under one according to birth rank.
Average ± standard deviation.

Birth rank	Bukavu (urban area)	Idjwi (rural area)	Kabare (rural area)
Children under 1			
1	3.42 ± 0.54 (22)*	3.28 ± 0.45 (22)	3.26 ± 0.52 (19)
2 - 3 - 4	3.34 ± 0.64 (44)	3,03 ± 0,52 (33)	2.99 ± 0.44 (40)
5 and over	3.38 ± 0.65 (38)	3,11 ± 0.66 (38)	3.05 ± 0.49 (45)

* Number of children

Table 34

Indicators studied and incidence of death during the year after hospital discharge for protein-energy malnutrition in children under 2 years old.
Levels of significance : N.S. = Not Significant ; *** P under 0.001

CHILD :	AREA	N.S.
	BIRTH RANK	N.S.
	SEX	N.S.
	AGE AT ADMISSION TO HOSP.	N.S.
	ANTHROPOMETRIC DATA	N.S.
	ALBUMIN	N.S.
	LENGTH OF STAY IN HOSP.	N.S.
MOTHER :	INTERVAL BETWEEN BIRTH	***

In those parts of the world where breast-feeding is customarily practiced by all, and modern contraceptive methods almost unknown, the interval between births is linked with the duration of breast-feeding. When a lactating woman becomes pregnant again, she puts an end to breast-feeding more or less rapidly, thus depriving the last-

born child of a high quality energy and protein food and a precious source of anti-infectious factors. In addition, this ending of breast-feeding may go along with psychological and emotional weaning. These few facts indicate the major effect of family composition, and more particularly of the interval between births, upon the health of the mother and the children. They once again confirm the absolute need to introduce planned parenthood programmes in all actions aimed at improving family health and nutrition.

IV. METHODOLOGY OF DATA COLLECTION

If we are to inventory the essential indicators of nutritional status in a population group and identify the major related factors, collective work is required, and the quality of this work depends on the quality of the work done by each individual. In addition, this requires that some rules be respected in collecting data, and that the work be perfectly organized.

The main rule in collecting data is definitely that the methods used must be standardized. It is a fact that only results which have been observed, measured and recorded in an identical fashion may be compared with each other. One very simple, everyday act is weighing a child. If the weight of the same child is to be compared at different times of his/her life or with the weight of many children weighed in different centres, we must clearly define the weighing situation (child naked, lying down, etc.) and also the means of measurement (using a given scale until a certain age, etc.). The quality and precision of the equipment should be checked regularly (adjustment of the scales, etc.). The same is true of any other observation, measurement, laboratory test or community survey. This means that when observations are left to the appreciation of the individual worker they are of no use to the community ; in collective work it is useless to say that an oedema is large or small ; the only important point is the presence or absence of oedema, unless we succeed in achieving quantification of the extent of oedema.

This standardization of the methods used in an essential step, since its absence makes any subsequent interpretation dubious and considerably limits the value of many everyday acts. There is no sense in comparing the data collected in a same region, say, at a ten-year interval, if the methodology used is not strictly the same, and this is rarely the case.

The standardization of work methods requires the establishment of a very specific protocol for each observation, each act to be accomplished. This precision and strictness in the observations and measurements performed will enable us to go much further in the analysis of the findings. Let us take a simple example : it has been claimed, and probably rightly so, that rural African women always take their breast-fed child with them as they move about. Unfortunately, this type of assertion is never quantified and specified. Nowadays, in some regions, mothers leave their child at home when they go to work in the fields, and therefore decrease the number of feedings. Is this a new phenomenon ? Have the mothers'attitude toward their children changed, as the earlier assertions would lead us to believe ? Only specific, repeated observations over a period of time would enable us to analyse this behaviour. It is in fact possible to quantify the duration of "mother-child" contacts and assess the number of mothers who move about without their child, for example. The lack of such information considerably discredits our interpretation of them.

In conclusion, only standardized methods, using precise measurement, enable us to make valid conclusions of use to the entire population.

Perfect organization is required for the acheivement of this collective work. We must therefore define who does what, where, how and when.

WHO ? Since nutritional status is so greatly influenced by and linked with the pathology most frequently encountered in the non-industrialized countries, the participation of all members of the health personnel is required. Every one has a fundamental role to play, and should participate in this ongoing evaluation, in the identification of the main nutritional problems. It is out of the question to leave data collection to a team specialists ; rather, everyone must be motivated to take on the indispensable task which is allotted to him/her in this operation. In practice, this is what really happens in the field, but too often the methods are not standardized and the analysis of data is neglected.

WHAT ? The indicators of individual nutritional status must be described and sought by identifying the major nutritional problems in a region as well as the high-risk groups (for death or major sequelae). The main familial and environmental factors influencing nutritional status should also be sought.

WHERE ? Health workers may apply this approach in the health structures (hospitals, mother and child care centres and primary health care centres). At the same time, they should make sure that the expressed demand, that is the medical consultation, actually corresponds to the problems and needs of the population, thus defining the extent of nutritional problems for the population as a whole. At certain times, these health workers must leave their health structure and go out to meet the population in the villages and neighbourhoods, and visit the families living there. They cannot examine and observe everyone, however, and this raises the problem of selecting a sample for examination, and of the representativity of this sample. Various methods have been suggested and applied ; each has its advantages and disadvantages. A proper balance must be found in each region between the theoretical, intellectual approach and the practical possibilities, taking into account the fact that it would be just as absurd to invest all of our financial and human resources in the achievement of surveys outside of the health structures as it would be to neglect this approach completely.

HOW ? If our action is to be continuous and not necessarily require high complementary expenses, we must start with the existing structures, that is, the hospitals and health centres. Indeed, if a nutritional problem exists and is extensively present in the community, it will be seen in the health structures. If goiter is highly prevalent in a region, for instance, cases of goiter will certainly be seen in persons hospitalized, even if they did not consult for that reason. The hospital structures enable us to observe the most severe cases, and above all, they have or should have a functional laboratory, one adapted to the needs of the region. Health centres are often less well equipped, but on the other hand they offer a more appropriate setting for longitudinal studies, since they care for children throughout their growth, and for pregnant and lactating women during the greatest part of their fertile life. Alongside of this work within the health structures and using the results of this work as a basis, ongoing surveys within the community will describe the nutritional status of the population as a whole, thus providing a more epidemiological approach to the problems. If these surveys are to be simple and inexpensive, they must be limited to the major indicators brought to light by the analyses done in the health structures. Subsequent analytic studies will complete the first descriptive observations.

It is important to remember that the evaluation of the nutritional status of population groups is essentially based on the identification of the risk factors and above all

on the risk of death. This approach therefore requires that patient follow-up be perfectly organized : follow-up in hospitals (intra-hospital mortality), in consultations (seeking out children who no longer consult, etc.), and in families. No heavy technical means are required, but the work must be very well organized.

WHEN ? Ideally, this evaluation should be **ongoing**, for the following reasons :

— the work done in the health structures is of an everyday nature : the nutritional status of patients is closely linked with their state of health and the most severe forms of protein-energy malnutrition may rapidly end in death ;

— surveys done within the population should take possible monthly variations into account in the urban areas (linked with money income), as well as the frequent seasonal variations in the rural areas (linked with the farming calendar). In addition, infectious diseases also show major seasonal fluctuations ;

— last, these surveys should be done each year, since familial and environmental conditions change gradually with time. The influence of decreased soil productivity, for instance, may go unnoticed for months but become apparent only after several years of gradual deterioration of the nutritional status of people in the region. The analysis of retrospective data is often hazardous, due to a lack of standardized methodology or, more simply, for lack of data. We must therefore now begin to set up a permanent organization for the definition of the present nutritional status and which will serve as a point of comparison for subsequent evaluations.

V. METHODOLOGY OF DATA ANALYSIS

The correct analysis of the data collected depends upon three basic phases : data processing, the expression of the results and last, their interpretation. The quality of each of these phases conditions the quality of the analysis.

Data processing

Data should be processed continuously, and at two complementary levels ; local and regional (or national).

Processing must be done locally, and with the participation of all those who collect the data. This may represent extra work for these people, but it is indispensable, since their participation :

— enables the population to be informed of the results ;
— encourages thought and positive criticism of the data collected, based on personal knowledge of living conditions ;
— motivates the personnel ;
— enhances the value of each person's work and of the evaluation, and ensures us that the work will be well done.

On the local level, processing may be done manually or using small adding machines, and therefore costs very little and requires no special preparation of the data.

Processing should also be regional or national. It is then done by teams of specialists using more sophisticated means such as a computer. Such processing makes a more complete analysis possible, but also has the following disadvantages : analysis is delayed, no participation of the first-line personnel, feedback to the local community is not guaranteed. The process may be speeded up by using precoded records, by organizing the rapid transferral of data and by programming the analysis in advance.

We may also obtain the participation of the health personnel by providing each worker with an explanation of the results, but such passive participation is definitely less satisfactory than active collaboration.

For all of these reasons, the two types of processing should be done in a complementary fashion.

Expressing the results

The data collected for each individual must next be analysed. They may be grouped by age, sex, ethnic group, standard of living, etc. The variables may be quantitative and on a continuum (serum albumin concentration, for example), or quantitative and discontinuous (number of children in the family), or simply qualitative (oedema present or absent).

The results may be expressed either graphically (as histogrammes, weight or height curves) or as indexes summarizing the results (arithmetic average and standard deviation). Attention must be paid to the fact that an average may very well remain unchanged while the distribution around the average varies considerably ; this may have different effects on the health of the community. In expressing results, an effort should be made to specify the thresholds below which a risk - such as mortality- increases, and to what extent it increases.

Once the data is grouped, simple tests such as the X^2, the Student test, correlation tests and non-parametric tests enable us to analyse the results and to seek correlations between the different variables.

Interpreting the results

Like data processing, the interpretation of the results may be done at two complementary levels (figure 14) :

— the first level is local. Individual data are compared with those of people living in the same environment. If such local references are lacking, the results obtained at prenatal and infant consultations and by field surveys are used to establish them. A child's weight and height is thus compared with the weight and height of children of the same age living in the same region. By using local curves, we take family factors and those linked with the environment into account. The local objective is then to define those children at a high risk of death, the situations contributing to this risk, the groups most affected by protein-energy malnutrition, etc. ;

— the second level is regional and/or national. The data for a series of families are compared with those of other families living in different environments. It is of special interest to compare them with data for families living in what are considered as optimal conditions ; that is, generally, with families in industrialized countries or from privileged groups.

It is not a simple matter to interpret epidemiological results, and strict logic is required in their analysis.

When a relationship exists between the illness and a factor (a link not due to chance), it remains to be determined whether we may interpret it as a direct causal relationship. Some conditions underlying the existence of an aetiological role have been described. Four are basic : a time sequence, a strong link, coherence and the existence of a gradient of the risks.

Thus, only a strict analysis of the pertinent data, collected correctly, may lead to the conclusion that a relationship exists between a factor and a nutritional illness, showing its importance for individual health and enabling us to plan health actions of value to individuals and to the entire population groups involved.

Figure 14

ONGOING DATA ANALYSIS AT TWO LEVELS

In processing

1. local, with the participation of those who collect the data.	1. individual data is compared with data of people living in the same environment.
2. regional and/or national, using more sophisticated means.	2. data for a series of families is compared with data from other different series' of families (from a different environment).

VI. HEALTH ACTIONS AND EVALUATION

Health actions also take place on two levels :

— a local level, with mostly secondary and tertiary preventive actions (detection of mild forms, early treatment of infections, reintegration of hospitalized patients, etc.) ;

— a more general, longer term level, with the organization of primary preventive actions (environmental hygiene, family education, improvement of soil productivity, improvement of standard of living, etc.).

This approach to the evaluation of the nutritional status of individuals necessarily leads to health actions whose objective is not limited to the improvement of people's diet and nutrition. Indeed, programmes for planned parenthood, vaccination, environmental hygiene, the early treatment of diarrhoea are actually as important if not more so, in improving the nutritional status of a community than a programme providing food complements. Only the integration of all of these activities may lead to improvement of the nutritional status of a population group. The logical conclusion of this line of thought is that the isolated creation of centres for nutritional rehabilitation will have little or no influence on the nutritional status of a population group, and this has been proved by many examples.

We must be able to evaluate all health actions, so as to measure the eventual changes. This idea is not to criticize, but to understand what we are doing, and to make sure that our actions are pertinent and correct. The fact that this analysis leads to action improves the effectiveness of the system. Last, the evaluation of health actions is done by collecting more data, judiciously chosen according to the objective sought, thus improving the pertinence and the quality of the data collected. It is not enough to undertake actions, we must also change people's attitudes toward these nutritional problems :

— change the attitude of health workers, making them more aware of the seriousness of these problems ;
— change the attitude of officials for the region, by explaining the results of our work to them ;
— change the attitude of the population by obtaining its participation in a responsible choice.

ANNOUNCEMENT

"Where there is no dentist" is written in English for basic health workers, teachers and parents. Its conception is similar to that of D. Werner's "Where there is no doctor" : practical, easy to read, thanks to its simple vocabulary, numerous illustrations and examples of appropriate technology in the field of dental care.

In the first part, the author emphasizes the prevention of buccodental diseases by proper diet and tooth brushing, as well as the transmission of knowledge to the community. A long chapter is devoted to education and activities at school.

In the second, more technical part, he discusses the different buccodental diseases : their diagnosis, the treatment of the most common ailments, the equipment, drugs and records are discussed in a practical manner, along with the moment when an ailment requires the attention of a specialist. Some ideas for making equipment using local means are suggested.

Given the importance of a healthy mouth for a healthy individual and community, and the increasing frequency of the diseases which affect it, it is highly recommended that all those involved in improving community health read and use this book. It may be translated and adapted to the specific needs of a country or a region.

"Where there is no dentist", by Murray Dickson (1983), may be obtained by writing to :

Hesperian Foundation
P.O. Box 1692
Palo Alto, California
94302 U.S.A.

THE INTERNATIONAL UNION FOR CHILD WELFARE (IUCW), in Geneva, has just published issue n° 61 of the INTERNATIONAL CHILD WELFARE REVIEW. The review, which has been published quarterly for 63 years, highlights essential information for all those concerned with children, families, social action, and development.

The latest issue features two key articles :

A SPECIAL BEING, DOING A SPECIAL JOB, IN A SPECIAL PLACE, by Jean Traber, and BUSINESS PRACTICES AND CHILD WELFARE, by Michel Kostecki. In addition, the various regular features constitute a mine of concise and precise information :

— Worldwide : three months of developments in the social field.
— International Meetings : principal international meetings on the subject of children and youth.
— Through the Grapevine : new publications, new services.
— International News : reports on the activities of the International Association of Workers for Maladjusted Children (IAWMC), the International Association of Juvenile and Family Court Magistrates (IAJFCM), the International Federation for Parent Education (IFPE), the World Movement of Mothers (WMM) and the Friends of Youth World Association (AMADE).
— IUCW Column : devoted, in the latest issue, to the SECOND PREPARATORY MEETING ON THE INTERNATIONAL ALLIANCE ON CHILD ABUSE AND NEGLECT.

Each issue of the INTERNATIONAL CHILD WELFARE REVIEW includes a free LIBRARY supplement which provides readers with a list of important recent books and articles together with abstracts.

The INTERNATIONAL CHILD WELFARE REVIEW may be ordered from : IUCW, PO Box 41, 1211 GENEVA 20, Switzerland. Annual subscription (four issues) costs 39 Swiss francs for Europe and the Mediterranean Basin by surface mail, and 49 Swiss francs for all other countries by air mail.

NOTICE

The following back issues of "Children in the Tropics" are still available:

84 The protection of the pregnant woman.
87 Mayor eye diseases in intertropical Africa.
88 Surgical emergencies of childhood in African rural environment.
89 Veneral diseases.
90 Malnutrition in Niger.
91 An approach to family health. The integrated mother/child clinic.
92 Obstetric emergencies in rural Africa.
97 Evolution and prospects of the food situation in the Ivory Coast.
107 Food-nutrition-health and development.
108-109 Primary health care.
110 Family health and birth control.
111 Poliomyelitis.
112 Sex education in traditional life in black Africa.
113 Reflections on a strategy for education for health.
114 Vaccination: organization, technique and evaluation.
115 Proposals for improving the quality of water.
116 Sexually transmitted diseases in children.
117-118 The child from conception to age 6.
119 The Diagnosis and prophylaxis of enteric parasitores.
121 Improving nutrition... What is required?
122 Traditional medicine.
123 Children and accidents.
124 Going from understanding needs... to health activities.
125 Children and their biological rhythms.
126 Supplying water to villages.
127 Some elements of treatment.
128 Health habits: a learning experience.
129 Primary health care: what is required.
130 Improving the rural habitat in Africa.
131 The motor disabled children.
132 Children and their teeth.
133 Nutritional anaemia
134 Basic notions of paedriatric ophthalmology.
135-136-137 Small children : their initiation to life
138-139-140 How to feed young children
141 Family planning training and community needs
142 Functionnal literacy and its implications for the strategy of primary health care
143-144 Renewable energy resources, health and food in rural areas
145 Acute childhood respiratory ailments
146 Third world women at work
147-148 The principal foods : their composition, conservation and transformation

These issues may be purchased for 20 French Francs or 4 US Dollars each, by writing to the following address:

"Children in the Tropics"
International Children's Centre
Château de Longchamp, Bois de Boulogne
75016 Paris (France)

Last Name .....
First Name .....
Profession .....
Mailing Address .....
.....
City .....
Country .....
I wish to receive issues numbers .....
.....

The triple issues may be purchased for 30 French Francs (or 6 US $ or 1500 CFA) by writing to us

Enclosed is:
Check or Money Order*
to the order of CENTRE INTERNATIONAL DE L'ENFANCE
C.C.P. PARIS 5020.37

* Indicate which one.

SUBSCRIPTION FORM

Return to: CHILDREN IN THE TROPICS
Centre International de l'Enfance
Château de Longchamp
Bois de Boulogne, 75016 PARIS (France)

LAST NAME .....

FIRST NAME .....

PROFESSION .....

.....

MAILING ADDRESS:

— Street or P.O. Box .....

— City .....

— Country .....

I WISH TO SUBSCRIBE TO "CHILDREN IN THE TROPICS"

(6 issues per year) - Subscription rates : 100 French Francs
or 17 $ U.S.

Enclosed is : CHECK or MONEY ORDER*
to the order of CENTRE INTERNATIONAL DE L'ENFANCE
CCP PARIS 5020.37

Date ..... Signature :

N° 149/150

If you are already a subscriber and have recently changed your name or address, please fill out the following form (print legibly):

Former address	New address
Last name	Last name .....
First name	First name .....
Profession	Profession .....
Address	Address .....
City	City .....
Country	Country .....

* Indicate which

BEST COPY AVAILABLE

Founder: Prof. J. SENECAL
Managing Director: Prof. J. GUIGNARD
Editor in Chief: Dr A.M. MASSE-RAIMBAULT
Imprimerie Rosay, 47, avenue de Paris, 94300 Vincennes - Dépôt légal : 4e trimestre 1984 - N° 655